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PLANS AND SPECIFICATIONS FOR A NEW WATER supply for Jersey City are to be drawn by Mr. C. C. Vermuele, of 71 Broadway, New York city, in accordance with a resolution passed Feb. 27 by the street and water commissioners. The resolution directs the engineer to work in conjunction with the commissioners, and fixes his salary at the rate of $3,500 a year.

THE COMPLETION OF THE WASHINGTON AQUEduct tunnel is authorized in a bill recently introduced in the U. S. Senate. An abstract of the expert's report recommending this work was published in our issue of Feb. 20, 1896.

DAMAGES AGAINST THE CITY OF PHILADELPHIA to the amount of $26,317 for annulling the contract for the Queen Lane pumping station have been awarded to Jacob Wenzelberger. The contract was awarded on Nov. 20, 1893, for $152,430, Mr. Wenzelberger being the lowest bidder. The station was to be located on land under the jurisdiction of the Park Commissioners, and they insisted on changes in the plans. An arrangement was made for $59,000 extras on this account, but the city afterwards decided to readvertise for bids, and finally let the contract to another party for $65,000 less than Mr. Wenzelberger's second bid. Before the changes were ordered Mr. Wenzelberger let three sub-contracts for the work, aggregating $116,000. The sub-contractors brought suit against him for damages. The referee decided that the sub-contractors would have made an aggregate profit of $20,566, and $26,317 was awarded, as stated above.

BIDS FOR AN INTERCEPTING SEWER AT HARTford, Conn., will be received until April 1, as stated in our advertising columns. The sewer will be of brick, from 24 to 56 ins. in diameter. This work is the outcome of years of agitation to divert sewage from the Park River and its branches. The new sewer will discharge into deep water in the Connecticut River. The system was designed by Mr. Rudolph Hering, M. Am. Soc. C. E., as consulting engineer. Mr. C. H. Bunce is city surveyor of Hartford, and Mr. Chas. H. Northam is president of the board of street commissioners.

A GARBAGE CREMATORY FRANCHISE IN SAN Francisco has been awarded to Mr. F. E. Sharon by a vote of 8 to 4. Mr. Sharon's offer was $2,500 in cash, 2% of the gross receipts for the first 15 years and 5% for the remaining 35 years of the franchise. The other bids were given in our issue of Feb. 20.

CITY COMMISSIONERS ARE TO BE CIVIL ENGIneers hereafter in Baltimore, Md., in accordance with a recent amendment to Section 63 of the City Code as follows:

There shall be appointed biennially in the month of March, by a joint convention of the City Council, a City Commissioner, who shall attend daily at his office, and there shall be also appointed three Assistant Commissioners, who shall be under the direction of the said City Commissioner; said City Commissioner and Assistant City Commissioners to be practical civil engineers of not less than five years' actual experience, and the entire time of both commissioner and assistants shall be devoted personally to the interests of the Corporation; and should it be ascertained that any of the aforesaid officers is engaged in or connected with any business or pursuit other than that appertaining to his official duties, it shall be deemed good and sufficient cause for his removal.

DRAFTSMEN ARE WANTED at good pay by the City of Brooklyn. At a recent civil service examination of candidates for vacancies, only six presented themselves, and the examination is to be repeated in a short time. Further information can be secured by addressing Mr. Elmer E. Johnson, Asst. Secy.

THE NEW NAVY, since March 3, 1883, has cost $110,371,710, according to the late speech of Senator Proctor, of Vermont; he included in this statement all ships authorized or in course of construction. In the same time we have expended only $10,631,000 on coast defenses, and many millions in deepening the approaches to our harbors and making them more accessible to an enemy's fleets. For the sum named the United States will have 8 battle ships, 4 double-turreted monitors, 1 barbette coast defense turret vessel, 1 harbor defense ram, 2 armored cruisers, 7 protected cruisers, 6 partially protected cruisers, 20 cruisers, 17 gun boats, 1 dynamite gun vessel, 9 torpedo boats, 1 despatch boat and 1 naval cadet practice vessel. These ships will carry 82 8-in. guns, 18 10-in. guns, 42 12-in. guns, 24 13-in. guns, 3 dynamite guns, and 184 5-in. and 6-in. rapid fire guns. Senator Proctor argued that land defenses were more efficient than a navy for the protection of our coast-line, and said that our navy having been well advanced, we should now turn our attention to the shore defenses, as the best means of maintaining peace.

THE ACCIDENT TO THE ROCK ISLAND BRIDGE over the Mississippi River, noted in our last issue, is further described in a letter to us from Mr. Ralph Modjeski, Assoc. M. Am. Soc. C. E., Chief Engineer, as follows:

One arm of the new drawspan was being erected and was within twelve hours from being coupled up safely. Unfortunately a very sudden rise of the river loosened the ice, which was considered very solid, and carried away the falsework with three panels of the new drawspan. No lives were lost, and only one man was very slightly hurt. The Phoenix Bridge Co. had the contract for erection, as well as for the superstructure. The damage is not very great, only about 100 tons of material being lost. Last week's frosts, which led every one to believe that the ice would hold for some time, justified the contractors in going ahead with the erection. Once the erection begun, it could not be stopped.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was the derailment of two trains on the Stone Creek trestle of the Southern Ry., near Macon, Ga., Feb. 29. A rail had been removed by wreckers. The first train was an express from Atlanta for Jacksonville, and shortly after it was followed by a freight train. Both trains went down into the creek. Three men (the two firemen and the baggageman) were killed, and five persons were injured.

THE FLOODS IN NEW ENGLAND caused by the recent rain storms have resulted in considerable damage along the rivers. At Dover, N. H., a bridge over the Cocheco River was carried away March 1. At Manchester, N. H., three bridges over the Merrimac River were carried away, and two others badly damaged by water and floating ice. A dam near the city was broken. Numerous washouts have occurred along the railways.

THE BALTIMORE & OHIO R. R. has gone into the hands of receivers, and it is stated that the financial affairs are in a very bad condition. The road was chartered in 1827, and its first piece of line was operated by horses until 1830. It is one of the largest and most important trunk lines reaching the Atlantic seaboard, and was eminently successful until after the death of Mr. John D. Garrett. It has a system comprising 2,094 miles, exclusive of the Baltimore & Ohio Southwestern R. R., by which it obtains access to Cincinnati and St. Louis.

A JURY PROPELLER is on exhibition in Tacoma which was made by Joseph Rose, Chief Engineer of the steamer "Strathnevis," which lost her propeller through the breaking of the shaft and floated helplessly for weeks on the Pacific. The improvised propeller is 7 ft. 6 ins. in diameter, and the four blades were made of ⅝-in. boiler plate, reinforced by several layers of the same material near the center, and attaining 6 ins. in thickness at the hub; the several plates being firmly bolted together. The intention was to select calm weather and shift the cargo forward sufficiently to bring the end of the broken shaft out of water. The new propeller was then to be bolted to the end of the shaft. This was not carried out, however, as the disabled steamship was towed to port by the "Miowera."

LOCOMOTIVE GRATES FOR BURNING ANTHRAcite are being investigated by a committee of the American Railway Master Mechanics' Association, and a circular has been issued asking for details of such grates and the experience had with them, the main point being to decide whether a water-bar or a cast-iron shaking bar grate is the most suitable.

ELECTRIC HEADLIGHTS, made by the National Headlight Co., of Indianapolis, Ind., are being used on the Chesapeake & Ohio Ry., and double headlights with reflectors set so that the right and left hand lamps throws their light to the left and right hand sides of the track respectively, are being tried on some of the express engines of the New York, New Haven & Hartford R. R. The object of the double headlight is to give greater efficiency on curves.

A SOFT-STEEL-CAPPED PROJECTILE, made by the Johnson Co., of Spuyten Duyvil, N. Y., was successfully tested at Indian Head on Feb. 25. The remarkable feature of the test is that while the target was a Harveyized armor-plate 7 ins. thick, the shell, fired from a 6-in. gun, was made of cast iron chilled by a special process. On the tip of this shell was a soft-steel cap or point, no detail of which can be secured. Of the three shells fired, two fulfilled all the requirements of the test; but the third went completely through the 7-in. armor-plate and the heavy backing and then 14 ft. into a dirtbank behind the target. This cast-iron shell overturns all present theories upon armor-piercing projectiles, and in results ranks with, if it does not outrank, the mysterious Russian experiments of several years ago.

THE LAKE ERIE & OHIO RIVER CANAL scheme has been reported on by Gen. H. L. Abbot, Maj. N. H. Hutton and Prof. L. M. Haupt, as a board of consulting engineers. They recommend a depth of 15 ft. as best suited to the bulk of the expected traffic. With a bottom width of 100 ft., a surface width of 152 ft. and locks 340 ft. long,; the estimated total cost is within $30,000,000.

THE NEW EAST RIVER BRIDGE plans, as revised by Chief Engineer Buck, have been approved by Secretary of War Lamont, on the recommendation of the board of engineers convened for that purpose. These plans provide for a clear height of 135 ft., under the center of the bridge at mean high tide, and for 200 ft. on each side of the center. At the piers the clear height will be 117 ft. The commissioners of the bridge, at their last executive meeting, ask the cities of New York and Brooklyn to provide $500,000, in bonds, to be used in construction. The total disbursements, to Feb. 29, was reported as $36,308.

NONE BUT DOMESTIC PAVING MATERIALS may be used in New York state, if a bill now before the legislature succeeds in its passage. The bill is practically aimed at foreign asphalt companies, as no other material would be affected. The foreign brands are the Trinidad, Venezuelan and European rock asphalts, now controlled by about seven competing companies. The only American asphalts yet fully developed are those of Lower California and Utah. The foreign companies affected do not regard the bill seriously, and look upon it as too unreasonable and unjust to pass. It is questionable whether such a statute would be sustained by the courts even if it were enacted.

PLANS FOR A NEW MUNICIPAL BUILDING for New York city were called for in 1893, and about 130 architects entered the competition. Afterwards the bill authorizing the construction of the building in City Hall Park was repealed, but the appropriation for prizes was allowed to stand. All but six of the plans were rejected by the committee of architects appointed by the commission, and the awards have just been made as follows, the first prize being $7,000, and all the others $2,000: 1, J. R. Thomas, New York city; 2, Edward P. Casey, New York city; 3, Rankin & Kellogg, Philadelphia, Pa.; 4, Gordon, Bragdon & Orchard, Rochester, N. Y., 5, Ernest Flagg, New York city; 6, P. D. Weber, Chicago, Ill. The examining committee was composed of Napoleon Le Brun, Stanford White, and the late Richard M. Hunt.

THE SAULT STE. MARIE SHIP CANAL was open 213 days in 1895. In that time 12,495 steamers, 4,790 sailing vessels and 671 unregistered craft passed through. This is an average of 77 vessels each day and a little over 30 lockages per day. These vessels had a registered net tonnage of 16,089,778 tons, and the freight carried amounted to 14,471,648 net tons. The New York "Journal of Commerce" says that in 1895 only 3,434 steamers passed through the Suez Canal, or about 10 per day. The tonnage for the year is not stated; but in 1894, with only 82 less vessels, the net tonnage was 8,039,105. The tonnage of the Suez Canal, in 1895, therefore, probably was but little more than one-half of that carried through the "Soo" Canal in less than eight months. The larger items of freight on the latter canal included 2,500,000 tons of coal, nearly 9,000,000 barrels of flour, over 41,000,000 bushels of wheat and about 8,000,000 bushels of other grain, and nearly 8,000,000 tons of iron ore. As compared with 1894, the American canal passed 16% more vessels, made 9% more lockages, recorded 23% increase in registered tonnage and 10% increase in the amount of freight carried. On July 17, the lock passed 119 vessels. The Canadian lock was finished last year and was open 87 days in the fall. In this time 1,163 vessels passed through it, carrying 590,932 tons of freight and having a net registered capacity of 717,003 tons. Taken together, the two canals fully doubled the tonnage passing through the Suez Canal in 1895, with more than four times the number of passing vessels.

RAPID ERECTION OF A DECK PLATE GIRDER.

The Cleveland, Akron & Columbus Ry. Co. has been reconstructing its bridges during the past season; replacing old Howe trusses with modern steel structures, designed to carry two 120-ton locomotives, with a following load of 3,500 lbs. per lin. ft. The specifications used were those of the Louisville & Nashville R. R. Co., with slight modifications.

Ten spans of this work were awarded to the Youngstown Bridge Co., of Youngstown, O., most of it being pin-connected Warren trusses, except the bridge shown in our illustrations over Big Walnut Creek, which consists of two 91-ft. deck plate-girder spans 9 ft. deep, on steel columns. The height of this bridge above the water is about 50 ft. It being necessary to keep up traffic during the erection of the structure, it was thought best to resort to somewhat unusual means for a span of this size, riveting each span up complete on

Erection of 91-ft. Span, Girder Suspended from Gallows Frames.

Girder Lowered to Final Position.

DECK PLATE GIRDER BRIDGE OVER BIG WALNUT CREEK, CLEVELAND, AKRON & COLUMBUS R. R.
Built by the Youngstown Bridge Co., Youngstown, O., C. E. Fowler, Assoc. M. Am. Soc. C. E., Chief Engineer.

the cars at the shops, and setting the spans in place between trains. The longest time between trains was on Sunday morning. Work was begun at daylight on Feb. 2 by shifting the girders onto the old bridge and lifting them clear of the cars by means of the gallows frames, shown in the illustrations. The first photograph was taken at 8 a. m., and the second at 11.15 a. m., just after the span had been landed on the steel columns. This was accomplished by tearing out the old deck of the Howe truss, the top lateral bracing and the cross bracing. Temporary cross bracing was spiked to the Howe truss diagonals to keep the old trusses erect. The new span was then lowered down between the old trusses and connections made. The new track was laid and the trains were allowed to cross just after noon.

The erection was carried on by Mr. A. L. Wymer, Superintendent of Erection for the Youngstown Bridge Co. The strain sheets and designs were made by the bridge company, under the direction of their Chief Engineer, Mr. C. E. Fowler, Assoc. M. Am. Soc. C. E., to whom we are indebted for the foregoing matter.

THE EFFECT OF ADDITIONS OF TITANIFEROUS TO PHOSPHORIC IRON ORES IN THE BLAST FURNACE.

By Auguste J. Rossi, New York City.

As is well known, practically all the phosphorus of the iron ores smelted in the blast furnace passes into the pig metal, increasing its fluidity, but diminishing its strength to such an extent that, if phosphorus exceeds a certain amount, the metal is only fit for fine castings, not required to resist strains, and it cannot be used for the ordinary purposes of good foundry iron.

Titaniferous ores are almost invariably Bessemer ores; and the pig metal obtained from them is a special iron, generally admitted to possess excellent properties. It is tough and hard, nearly white or light steel-gray in color, and characterized by its large percentage of combined, and small percentage of graphitic carbon.

It occurred to the author that by mixing in proper proportions titanic and phosphoric ores, the weakening influences of phosphorus on the metal might be counteracted to such an extent as to render such mixtures available for blast furnace use, in order to obtain a fluid, and at the same time sufficiently strong foundry iron for most purposes. If successful, this method would utilize a class of phosphoric ores not now possessing much value.

In experimenting in this direction, some very curious and, to some extent, unexpected results were obtained, the communication of which is the special purpose of the paper.

(The experiments are described in detail and the paper concludes as follows:—Ed.)

The curious fact brought out by these experiments is the peculiar influence which the presence of phosphorus seems to have exerted on the state of the carbon in the pig metal obtained from mixtures of phosphoric and titanic ores.

In short, while titanium in an iron ore (at least under the conditions observed in smelting these ores hitherto) has a tendency to throw the carbon in the metal into the combined state, the presence of a considerable amount of phosphorus simultaneously with titanium, in a mixture, modifies the conditions of existence of the carbon to the extent of throwing it almost all into the graphitic state, this effect being the greater the more phosphoric the mixture, and the greater the proportion of titaniferous ores used.

RECENT DEVELOPMENTS IN AMERICA OF MECHANICALLY-PROPELLED ROAD CARRIAGES.

II.

(With inset.)

In our issue of Feb. 27 we described briefly the different motor carriages actually contesting in the road race inaugurated by the "Times-Herald" of Chicago. Besides these, several motor carriages were submitted for laboratory tests which will be described here, together with a number of other carriages about which information has also been collected by this journal.

Other American Motor Carriages.

G. W. Lewis Motor Carriage.—This vehicle is shown by Fig. 1. It is mounted on four wheels with solid rubber tires and ball bearings, the rear wheels, 45.8 ins. in diameter, being the driving wheels, and the front wheels, 33.4 ins. in diameter, being the steering wheels. The wheel gage is 46½ ins. and the wheel base 56 ins. The power is generated by a single cylinder 5 × 5-in. gasoline engine of 2 HP.

The interesting feature of this vehicle is in the mechanism which transmits the power from the motor. The fly-wheel of the motor is also a disk from which the power is transmitted to the gears on the drivers by means of a friction pulley. On the bottom of the vehicle in front of the operator is a shaft upon which the operator places his foot to control the vehicle, pressure in one direction puts the vehicle in motion and in the other stops it. The speed and power gear is designed for pulling a heavy load or increasing speed as desired. In accomplishing this, the speed of the motor need not necessarily be changed. For example, if the occupant of the vehicle wishes to stop, he can set the motor to a slow speed and thus economize somewhat in consumption of fuel. The tank containing the gasoline holds enough for about a 100-mile run, and is located in the front near the water tank. The gearing is of rawhide, practically doing away with noise. Steering is accomplished by a bicycle lever in the center of the axle. Both wheels are operated by means of separate rods connected with the steering lever and are pivoted at the hub as close in line with the felloe as possible, to make the steering easy and prevent the lever from being jerked out of the hand when an obstacle is encountered. The battery which supplies the electric spark to the cylinder is placed behind the seat and in connection with it a very small generator is used to keep the battery in perfect working order. From the hind axle an adjustable connecting rod is fastened to the bearing of each of the driving sprocket wheels, keeping the distance from the center of the sprocket wheels to the hind axle the same under all circumstances, so that the chains will have the proper tension. This vehicle was submitted for the laboratory test.

Haynes & Apperson.—This vehicle weighs 1,250 lbs., and is mounted on four wheels with pneumatic tires and ball bearings, the rear wheels, 35.6 ins. in diameter, being the driving wheels, and the front wheels, 35.8 ins. in diameter, being the steering wheels. The wheel gage is 55½ ins. and the wheel base is 54 ins. The power is generated by a two-cylinder, 4 × 4 ins., gasoline engine. The results of the laboratory tests of this vehicle will be given further on.

Kane-Pennington Motor Carriage.—Fig. 2 shows the motor carriage built by Thos. Kane & Co., of Chicago, Ill., and fitted with a 2 HP. Kane-Pennington "electro-oil" engine. The wheels are 26 ins. in diameter with 4-in. pneumatic tires mechanically attached to the rims. The frame is of steel tubing. The front wheels are pivoted on ball bearings to permit of easy steering like an ordinary bicycle, and the rear wheels or drivers are so constructed that one can revolve faster than the other in turning corners. The brake consists of a pivoted rod held in place by a coil spring, and is operated by being thrown down to drag upon the ground.

The engines have two cylinders coupled to a single driving shaft, from which the power is conveyed to the drivers by sprocket chains. This engine consists simply of a thin steel tube cylinder with a tensile strength of 8,000 lbs., a piston

and connecting rod, an inlet valve admitting the oil, an outlet valve allowing the exhaust to escape, and an electric device for operating the engine. This engine employs the use of electricity, not only for ignition purposes, but also for deriving a great part of its power. Common kerosene or gasoline is admitted into the cylinder and the current from a small primary battery is utilized, (1) to convert the oil into gas, and (2) to explode it in the cylinder. This process, it is stated, forms a perfect combustible mixture so that there is no smoke or poisonous gases given forth from the exhaust, and the maximum power is obtained from the oil with no waste. Another noticeable reaction from this electrical process is the cooling of the cylinder caused by the rapid evaporation, so that only sufficient water is required to keep an equal temperature, and the water is used over and over again, being stored in a cylinder attached to the dashboard.

The oil tank for supplying the engine is placed under the seat. The weight of the engine is 120 lbs. and it occupies a floor space of 11×20 ins. The consumption of oil is stated to be one gallon per horse power per 14 hours run.

Benton Harbor Motor Carriage Co.—Fig. 3 shows the carriage manufactured by this company, whose works are located at Benton Harbor, Mich. It was invented by Mr. U. O. Worth and is operated by a hydro-carbon motor, designed like a balance piston-engine, and of 7 HP. The power is conveyed to the drivers by sprocket chains, and all mechanism is enclosed from dust. There are but two running gears, one of which is rawhide.

There are but ten bearings in the construction of this carriage, and these are composed of about 1,000 steel balls 5-16 in. in diameter, running on steel tempered and ground cones. Two levers are used in operating. One is the guiding lever, which is of balanced construction, and the other is for stopping, starting, reversing and applying the brake, and also for changing the speed, which is gradually increased or decreased without shifting gears or stopping the application in power from the engine to the driving wheel. The total weight with sufficient material for a 300-mile run is stated to be about 1,050 lbs.

Daley Motor Carriage.—Fig. 4 shows a gasoline motor carriage designed by Mr. M. H. Daley, of Charles City, Ia. The wheels are 28 ins. in diameter, 3 ft. tread, and have armored* pneumatic tires and ball bearings. The hind wheels are fixed to the axle and have ratchets to allow of reverse revolution in turning corners, while the front wheels are hung on bicycle frames to allow of easy steering, as shown by the illustration.

The power is generated by a two-cylinder gasoline engine of 2 HP., and is conveyed to a sprocket wheel running loose on the rear axle. This sprocket is put in action by a cone friction clutch actuated by a lever, and another lever connected with the governor regulates the speed. The brake consists of a foot lever operating a friction band on hind wheel hubs. The gasoline reservoir of two gallons capacity is located at the front of the carriage, and from it a pipe leads to the pump, which is regulated by a governor. The weight of the carriage is 95 lbs., and of the motor 100 lbs. The vehicle is retailed at $500.

Figs. 5 and 6 show two motor carriages which are worthy of note; the first for its motive power, which the inventor describes as a "complication of steel springs;" and the second because it is one of the few steam carriages with which we have met in collecting the information upon which this article is based. The motive power of the vehicle shown by Fig. 5 is obtained from a series of coiled springs, the uncoiling of which actuates a shaft from which a sprocket chain runs to the rear driving wheels. The weight of this "motor" is 110 lbs., and the weight of the whole vehicle is 220 lbs.; it is stated to cost $600 ready to run. The steam carriage shown by Fig. 6 is operated by a 1 HP. Corliss cut-off engine, from the shaft of which a sprocket chain runs to the rear axle. The weight of this carriage is given at 350 lbs., and its cost at $600.

Another steam carriage which has been pushed to some extent is made by the Hartley Power Supply Co., of Chicago. We have been furnished with the following description of this carriage:

> The motor's power is steam, which has an endless cylinder, thereby dispensing with cross-heads, crank-arms, etc. It takes steam by means of an automatic adjustible eccentric thereby using only the necessary amount of power to do its allotted work. The motor occupies a space under the conductor's seat, being entirely out of the way and completely hidden from view. The boiler or retort, which is 16 ins. in diameter by 20 ins. high, weighs 65 lbs. and stands in front of the conductor, generating the steam only as fast as it is required, and is so constructed that, in case of emergency, any kind of fuel can be used, but it is designed more particularly for oil or gasoline. The carriage proper will weigh about 500 lbs., while the motor, boiler and other attachments will weigh about 300 lbs. more.

Besides the vehicles illustrated, we have secured more or less complete information regarding a number of other American motor carriages, and the main portion of this has been incorporated in Table I. The great preponderance of gasoline engines over any other form of motive power, and the small use of electric power, are particularly noticeable in this table. Ball bearings and pneumatic or solid rubber tires are very commonly used. Various other features of general interest are spoken of on our editorial page and will not be mentioned here. It is not by any means to be supposed that the vehicles described in this and the preceding article includes all American motor carriages, but they do form the majority of those which have been developed to a reasonable point of success.

Laboratory Tests.

A prime condition of the motor carriage contest at Chicago was that all vehicles should undergo a laboratory test as well as traverse the course of 54 miles in the road race. The committee appointed to make these tests consisted of Messrs. John P. Barrett, M. Inst. Elec. Engrs.; John Lundie, M. Am. Soc. C. E., and L. L. Summers, M. Inst Elec. Engrs., all of Chicago. This committee submitted its report in February, 1896, and we abstract the features of most interest to our readers in the following paragraphs:

Tables II. and III. show the results of the power and duty tests of each motor carriage tested, and Table IV. shows the results of a series of tests to determine the wheel resistance. To make these tests, a testing apparatus of the character shown by Fig. 7 was constructed. Gasoline of 0.688 density

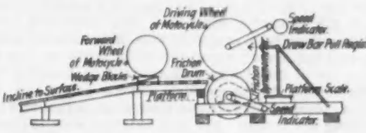


Fig. 7.—Diagram of Apparatus Used in Testing Motor Carriages, Chicago, November, 1895.

was used, and its cost was taken as 2 cts. per lb. The cost of electrical energy was estimated at 10 cts. per kilowatt-hour. The storage batteries were assumed to have an efficiency of 75%, making the cost per horse power-hour delivered to the motor 10 cts. The following is a partial abstract of the report:

> Tests for Maximum Pull.—In order to compare the performance of motor carriages with that of the horse, efforts were made to determine the maximum pull which the vehicle could exert as compared to that of the horse.

TABLE I.—Showing General Character of Recent Designs of Motor Carriages and Nature of the Power Machinery Operating Them.

Kind of motor.	No. of wheels.	Method of conveying power.
Hill Machine Co., Chicago..... Gasoline (1)	4	Fric-tion.
Otis E. Smith, Hartford, Conn..... Spiral springs (2)	4	....
Wolverine Motor Wks., Grand Rapids, Mich.. Gasoline (3)	4	....
John Templeton, Chicago..... Gasoline	3	Direct.
M. B. Mills, Chicago..... Comp. air	3	....
Magin Power Generator Co., Chicago..... Gasoline (4)	4	Chain.
A. C. Ames, South Chicago..... Steam (5)	4	Chain.
T. R. Gawley, Aurora, Neb..... Gasoline	4	....
Max Hertel, Chicago..... Gasoline	4	....
W. H. Brown, Cleveland, O..... Gasoline	4	....
Pierce Engine Co., Racine, Wis..... Gasoline (6)	4	Chain.
R. W. Elston, Charlevoix, Mich..... Gasoline	4	....
C. J. & J. W. Schoening, Oak Park, Ill..... Kerosene (7)	4	Fric.
P. E. McDonald, Chicago..... Pyro-pneumatic (8)	4	Chain.
Cronholm & Stenwall, Chicago..... Gasoline (9)	4	Gears.

Note.—(1) Two cylinder; 3 HP.; cylinders cooled by air jacket. (2) Six windings per 100 miles. (3) Two cyls. (5) Two HP. Scotch boiler. (6) Two cylinder, 3 HP. ball bearings, pneumatic tires. (4) Four HP. engine. (7) Seven HP. in space, 22×12×6 ins. (8) Expanded air heated by hard coal "consumed by new process." (9) The engine works on the principle of an ordinary gasoline engine and has two pistons connected to a crank shaft in each end of the cylinder, which lies across in front of the truck. The two crank shafts are connected by two pairs of two-to-one bevel gears to a counter shaft, which carries a number of gears for varying speeds, and lies above the axle, which carries a corresponding set of gears and also an equalizing gear. Most of the gears run loose on shaft and axle and when needed are actuated by a friction clutch and fork from the steering standard in front of the operator for getting the speed desired. The front wheels are the driving wheels on this machine.

*Thin steel band encased in rubber on outside of pneumatic tire proper, as shown by the illustration.

TABLE II.—Showing Results of Power and Duty Tests of Gasoline Motor Carriages at Chicago, November, 1895.

Contesting Motor Carriages.	No. of run.	Speed, ft. per min.	Pull exerted, lbs.	HP. exert. at rim of wheel.	HP. cons. in mechanism.	Total HP. developed in cylinder.	Mechanical efficiency.	Gasoline— Lbs. consumed per hour	Gasoline— Lbs. cons. per HP. H. at rim of wheel.	Ft. lbs. at rim of wheel per lb. gasoline.	Cost per HP. H. at rim of wheel—Cts.	Heaviest pull exerted—Lbs.	
De La Vergne R. M. Co., New York.....	1	619	37	.70	.71	1.41	.50	3.24	4.63	428,000	9.26	162	
(Benz Motor.)	2	1,000	51.8	1.57	1.40	2.97	.53	4.45	2.83	700,000	5.66		
Duryea Motor Wagon Co., Springfield, Mass. (Own Motor.)	1	432	83.8	1.10	.59	1.69	.65	4.01	3.64	545,000	7.28	187	(1)
	2	434	88.5	1.16	.59	1.75	.65	3.78	3.24	623,000	6.48		
Haynes & Apperson, Kokomo, Ind.....	1	376	23.1	.26	.61	.87	.30	5.78	21.8	91,000	43.60	119	(2)
(Own Motor.)	2	796	39.3	.95	1.28	2.23	.43	5.75	6.04	327,000	12.08		
Lewis, G. W., Chicago, Ill.....	1	353	49.9	.53	.53	1.06	.50	3.29	6.20	319,000	12.40	109	(3)
(Own Motor.)	2	491	17	.25	.65	.90	.28	3.28	12.8	149,000	25.60		
Macy, R. H. & Co., New York.....	1	521	52.1	.83	1.48	2.31	.36	3.22	3.90	515,000	7.80	103.7	(4)
(Roger-Benz Motor.)	2	945	87.2	2.50	2.68	5.18	.48	4.90	1.96	1,010,000	3.92		
Mueller, H. & Sons, Decatur, Ills.....	1	423	92.1	1.18	.61	1.79	.66	3.50	2.96	669,000	5.92		
(Mueller-Benz Motor.)	2	540	42.3	.69	.77	1.46	.47	3.87	5.60	354,000	11.20		
	3	564	38.6	.66	.81	1.47	.45	3.77	5.71	347,000	11.42	135.4	
	4	984	73.4	2.18	1.57	3.75	.58	3.40	1.57	1,268,000	3.14		
	5	1,168	34.7	1.23	1.86	3.09	.40	4.15	3.37	588,000	6.74		

Note.—(1) Trouble with igniter. (2) Two cylinders in use, only one supplying power. (3) Chain broke. (4) Belt slipped.

TABLE III.—Table Showing Results of Power and Duty Tests of Electric Motor Carriages at Chicago, November, 1895.

Contesting Motor Carriages	No. of run.	Speed in ft. per min.	Pull exerted, lbs.	HP. exert. at rim of wheel.	HP. cons. in mechanism.	Total HP. developed in motor.	Mechanical efficiency.	Electrical input HP.	K. W. hours supplied to batteries per HP. H. at rim of wheel.	Foot lbs. at rim of wheel per K. W. hour.	Cost per HP. H. at rim of wheel—Cts.	Efficiency HP. output, HP. input.	Heaviest pull exerted, lbs.	Input. Volts.	Amp.
Morris & Salom, Philadelphia. (Lundell Motor.)	1*	1,025	25.5	.78	.34	1.12	.70	1.36	1.74	1,138,000	17.4	.57	....	97	10.5
	2*	2,015	29	1.78	.68	2.46	.72	2.90	1.63	1,215,000	16.3	.61	....	96	22.5
Sturges Electric Motocycle Co., Chicago, Ill. (Lundell Motor.)	1	370	41	.41	.21	.62	.66	.94	2.41	818,000	24.2	.41	121	35	21
	2	892	42	1.14	.39	1.53	.74	1.94	1.70	1,165,000	17.0	.59		69	21

*Test ended by trouble with bearing.

TABLE IV.—Showing Results of Tests to Determine Wheel Resistance.

No. of test.	Nature of axles.	Nature of tires.	Mean diam. bearings, ins.	Rad. wheels loaded, ins.	Wgt. pair of wheels, lbs.	Total ld., incl. wheels, lbs.	Pull at tire due to axle fric., lbs.	Total pull at tire producing uniform motion.
1.....	Collinge	Steel	1⅜	24.5	68	659	5.4	8.84
2.....	Ball bearing	Steel	1¾	21.75	....	452	....	2.86
3.....	Collinge	Solid rubber	1⅜	18.9	75	657	2.64	5.49
4.....	Ball bearing	Solid rubber	1 15-16	24.2	....	645	....	2 36
5.....	Collinge	1¾-ins. Pneumatic (inflated).	1⅜	22.5	67	657	1.78	7.37
6.....	Collinge	1¾-ins. Pneumatic (deflated).	1⅜	22.1	67	598	....	10.57

The vehicles submitted were all designed for light passenger service and not to exert a heavy pull, so that a medium pull exerted at a high average rate of speed was the object sought rather than a heavy pull under adverse conditions. For determining this feature the pull on the vehicles was increased until the limiting conditions were reached, with the results shown.

The heaviest pull exerted, that with the Duryea vehicle, amounted to only 187 lbs. as compared to 400 lbs. which a single horse could exert. It was not possible in any of the tests made to slip the driving wheels, so that the traction in all cases was ample, and if a greater driving power had been available by means of reducing gearing, it would probably have been possible to obtain a correspondingly high result. In the case of the belt-driven machines of the Benz type, the limit was usually reached when the belts slipped. Owing to the defective conditions of the belts on the Macy machine, which possessed one of the most powerful motors of any of the vehicles submitted, the maximum effort was not obtainable. The Lewis carriage was equipped with a special reduction gear, enabling a very heavy pull to be produced. An effort to obtain this heavy pull resulted in breaking the driving chains. In the machines directly geared, any attempt to obtain heavier pulls than those given resulted in stalling the motors. The pull obtained with the electrical vehicles is, of course, only limited by the heating effects of the excessive current required.

It will be observed that there is a wide difference in the consumption of gasoline by the various engines submitted. In the Lewis and the Haynes & Apperson vehicles the cycle is such as to give an explosion every revolution, this type of engine being variously known in stationary practice as the single, Sintz or Day cycle. The exhaust from these engines was so densely laden with unconsumed carbon that an exhaust pipe and fume blast were required to convey the fumes from the testing room. The other motors presented were almost all operated upon the Otto cycle. In the Benz type of motor the gasoline was thoroughly carburetted before being admitted to the cylinder, while in the Duryea and others the gasoline was vaporized directly at the cylinder. The results obtained, therefore, enable a partial comparison to be made between these methods of utilizing the gasoline.

It is a well-known fact in gas engine operation that the economy of the engine at light loads is, if anything, inferior to the steam engine under similar conditions. In the application of the gas engine to a motor carriage the economy is particularly low for the reason that a considerable proportion of the power is sacrificed in driving the mechanism. Owing to this feature the consumption of gasoline per horse power hour at the rim of the wheel is quite large when the vehicle is operated under an ordinary load.

It is evident that under the best condition of load a horse power can be produced at the rim of the wheel with almost one-quarter the rate consumption of gasoline that it can under the worst conditions. With a type of vehicle such as the Duryea, where the speed of the gas engine is maintained constant, and the speed regulation is affected by changeable gearing, the economy with variable speed of the vehicle is dependent entirely upon the load carried by the engine. Under some conditions, therefore, it is possible for a motor carriage to ascend grades at the same speed as upon a level road and with the same consumption of gasoline per horse power-hour at the rim the engine may so increase the efficiency that it will enable it to give the increased power without increase in the consumption of gasoline. As far as possible it was endeavored to ascertain if the jolting of the vehicles using a carburetter would affect its action; in other words, if the explosive character of the mixture was varied by the effects of the vibration of the vehicle. So far as could be determined no effect was noticed in this respect; the carburetter apparently at all times supplying an even mixture.

The location of the driving engine and the method of transmitting the power to the driving mechanism greatly influences the amount of vibration there is in the vehicle. In the Benz type of vehicle the single cylinder engine, giving an explosion at every second revolution, is mounted with the cylinder at right angles to the axle of the driving wheels. The effect is to cause considerable vibration, and unless special means are adopted for counteracting this, it is transmitted to the body of the vehicle, resulting in more or less discomfort to the passengers at the time of starting, although afterward it is not so noticable. In the Duryea vehicle the two driving cylinders are parallel to the axle of the driving wheels and any reactive effect from the cylinders produces a vibration transversely. The vehicle of Messrs. Haynes & Apperson is provided with two cylinders, one on each side of the crank shaft, and the reactive effect is greatly diminished.

In considering the electric vehicles it is evident that in using a variable current from the storage batteries as the discharge rate is increased beyond the normal, both the life and efficiency of the battery will be diminished. In the Morris-Salom vehicles the batteries were rated at 50 ampere hours, with a discharge rate of 5 amperes. When discharging at a rate of 22 amperes it is evident that the available capacity of the cells will be greatly diminished. It is perhaps unfair to assume, therefore, that the efficiency will remain constant. While the mechanical efficiency is higher with a heavy load, the electrical efficiency as a whole may be diminished. The correction necessary for these factors will depend so largely upon particular conditions that no allowance has been made for them. The assumption of 75% efficiency in the batteries will be a fair average for normal conditions. The cost of electrical energy will also vary with the conditions, so that both of these factors must be considered in estimating the cost of operation. The heavy depreciation of the batteries when subjected to excessive discharges will also constitute a charge against cost of operation.

An interesting comparison may be made between the Sturges vehicle and that of Morris & Salom. Both of these vehicles are equipped with the same type of motor, the Sturges vehicle being propelled by a single motor of 3 H-P. while that of Messrs. Morris & Salom is propelled by two 1½ H-P. motors. A single axle with the wheel solidly mounted, the carriage being carried by the journals on this shaft after the pattern of a car journal, is the method of driving adopted in the Sturges vehicle, while in the Morris & Salom the pinion on the motor is geared directly to the driving wheels, the wheels being provided with ball bearings, and every effort being made to diminish friction.

The tests indicate that with the best workmanship possible the two motors have but a slightly higher efficiency than the single motor, though the mounting of the single motor is in a measure crude. The electrical and gear losses with two motors would, of course, be greater than with a single motor. The advantages of the series—parallel control of the motors when storage batteries are used and may be grouped to regulate the voltage—does not, therefore, seem necessarily to be a factor of sufficient importance to warrant the adoption of two motors. Apparently the only other factor to particularly commend this arrangement is the elimination of a differential gear, each driving wheel of the vehicle being separately connected by means of a sprocket chain to the same counter shaft.

Tests for Wheel Resistance.—A series of experiments was made with a view to determine the power consumed in wheel resistance, consisting of axle friction and so-called rolling friction, an effort being made to separate these elements with considerable success.

The method adopted in determining the power consumed in wheel resistance was to drive the wheels while resting on a drum of hard wood whose surface was smooth and which was so heavy as to show no perceptible distortion under the loads imposed, the power being measured at the periphery of the drum by the product of its speed and the tension on the dynamometer, to which the axle was connected.

In separating the effect of axle friction from that of other losses, observations were made by suspending a load from the axle of a single pair of wheels by a cradle and noting its deflections, which were multiplied by a long pointing arm, making quite a sensitive cradle dynamometer.

The same cradle loads and axle were used with different wheels and by comparing deflections under different circumstances an approximation to friction of direct or vertical bearing and friction or side thrust was obtained.

The analysis of loss due to the action of other parts of the wheel than the axle is only relative and was found by comparing the action of different tires mounted on wheels built up in the same way, having wooden hubs, spokes and felloes.

In the overcoming of axle friction the leverage of the radius of the wheel compared with the radius of the bearing gives a ready method of comparing the values of different mechanical bearings and of lubricants, and in order to appreciate thoroughly the problems involved in wheel resistance, losses due to axle friction must be recognized as separate and distinct from losses due to lack of resilience in the tires and other parts of the wheels. Some writers have assumed that summing axles and resilience losses together under the term "rolling friction" (a lazy term at best) was all that could be done owing to the difficulty of separating the two. We believe the method adopted in making the separation to be novel, and one indicating a line of future experiment in this direction which may be of value.

In discarding, then, the term "rolling friction" as indicating a compound action, the losses of power in wheels may result from the following factors: (1) Axle bearing friction. (2) Axle thrust friction. (3) Lack of resilience of tires and other parts of the structure of the wheel.

We were unable in the limited range of our experiments to analyze the third factor and thus the tire determinations involve a possible factor of the resilience of other parts of the wheel. (Resilience is here considered to mean the capacity of an elastic body to store and give out work done upon it.)

Table IV. gives the actual data and reduced results of the tests. These results may not seem to meet preconceived views, and it may therefore be well to briefly analyze the results in order to indicate what may be deduced from a close consideration of the wheel problem.

One naturally seeks an answer to such practical questions as, What kind of a bearing ought I to use? What tire is best suited for certain work? What ought to be the diameter for efficient service? And others of like nature. The limits of this report will not permit of more than an indication of the bearing of these experiments upon such questions. The following results may, however, be deduced from a consideration of the above data:

Table V.—Pulls per 1,000 lbs. of Total Load Required to Overcome Lack of Resilience in Wheels Under Examination. (See tests 1, 3, 5, and 6, Table IV.)

Kind of tire.	Lbs. pull.
Steel.....	5.23
Solid rubber.....	4.34
Pneumatic inflated....	8.5
Pneumatic deflated.....	14.6

As before mentioned, the axle friction, acting as it does, near the center of the wheel, is overcome by a pull which is inversely proportional to the radius of the wheel. In order, then, to properly compare axle frictions they should be reduced to pulls at equal distances from the center of the wheel. Deducing, then, from experiments we have:

Table VI.—Pulls per 1,000 lbs. of Load on Bearings of Collinge Axles Reduced to Uniform Radius of 12 ins. (See tests 1, 3 and 5, Table IV.)

Kind of tire.	Lbs. pull.
Steel.....	18.7
Solid rubber.....	7.5
Pneumatic.....	5.7

The question is naturally asked, What have the tires to do with the result? This leads to the consideration of what carriage builders call "set" and "gather" in wheels, both being designed to compensate for the distortion of a vehicle in operation. The "set" is a vertical adjustment of the axle, so that when the wheels are under working load the tread of the tire will be horizontal. The "gather" is a lateral adjustment of the axle, so that when the wheels are under average traction they will be parallel to the direction of motion of the vehicle.

In the case of a steel tire, unless the axle and tire adjustment is perfect, there is induced in the axle a side thrust which accounts for the abnormal axle friction shown above with the steel tired wheels used.

In the case of the solid rubber and the pneumatic tires the tire allows a more or less perfect adjustment to be taken naturally.

The loads in tests 1, 3, and 5, Table IV., were practically the same and the axles were identical, and in the matter of axle bearing friction the same co-efficients apply. Thus with the pneumatic tires the co-efficient of 5.7 lbs. per 1,000 at a radius of 12 ins. Table VI. represents bearing friction and very little, if any, thrust friction.

Reduced to the radius of the bearing, the friction figures 120 lbs. per 1,000, giving a co-efficient of friction between surfaces not too well lubricated of 0.12, which corresponds with the result of well-known friction experiments.

The difference between 18.7 lbs. on the steel tire wheel and 5.7 lbs. on the pneumatic, or 13 lbs., represents the pull per 1,000 lbs. at a radius of 12 ins. necessary to overcome the action of a side thrust.

Thus the elimination of a side thrust is a much greater factor in the reduction of power consumed by the wheels of a vehicle than the reduction of the friction of vertical bearing on the axle.

The larger part of the remainder of the report

is devoted to a theoretical discussion of the energy expended in the propulsion of vehicles, taking an assumed vehicle as the basis from which to argue:

The foregoing will give a pretty clear idea of the distinguishing features of recent American motor carriages, and will also suggest many points for study in the future development of such vehicles. In another column we have discussed this last question more at length.

THE PROPOSED MICHIGAN CENTRAL BRIDGE AT DETROIT.

In connection with the bill now before Congress providing for the erection of a bridge across the Detroit River at Detroit, Mich., a pamphlet has been issued setting forth the physical and commercial conditions at this point, and the reasons for the construction of a bridge. From this publication the following matter is abstracted:

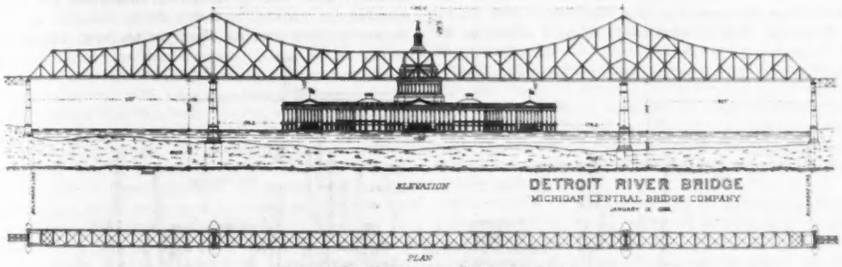
A railway map shows this crossing to be the gateway to a great section of country; and the fact that this crossing is now made by car-ferries, subject to ice-blockade for five months of the year, indicates how much of an obstacle this river is to the traffic of these railways. The writer of the report figures that, in the course of one year, 500,000 cars and 300,000 passengers are delayed or in some way interfered with by the partial embargo at this crossing.

The chief opposition to a bridge comes from the navigation interests of the lakes, and it is a vigorous and powerful opposition. To meet this, the promoters of the proposed bridge show that at Detroit the river is from 2,000 to 2,500 ft. wide for a distance of about 3½ miles, and that the navigation channel is from 35 to 50 ft. deep. With the proposed bridge located near Tenth St., in Detroit, there would be two miles of practically straight river above and over one mile of such river below the bridge. The current is not over two miles per hour as a maximum. The bed-rock is nearly level across the width of the river, and lies about 102 ft. below the surface of mean water; and immediately above this rock is a 20-ft. stratum of loose material, consisting of quicksand, gravel, clay and bowlders, with clay and some sand and gravel extending above this to the river bed. This conformation makes it necessary to go to the rock with any structure.

Tunnel-driving in this material has been tried, and some years ago $175,000 was expended on an experimental work of this character under the late E. S. Chesborough. Owing to water-bearing strata met with the headings of the trial experimental tunnel did not get nearer to each other than 1,700 ft., and Mr. Chesborough estimated that a tunnel sufficiently large for railway trains would cost from $7,000,000 to $8,000,000. Again, about six years ago, the subject of tunneling under the river was discussed, and the undertaking was carefully examined by skilled engineers and contractors. From the borings made, they reported that above the bed-rock the material encountered was either too soft to support a tunnel, or the presence of bowlders and glacial drift in the stratum immediately above the rock made success in tunneling, even with the use of a shield, very doubtful. Quicksand strata were also found bearing large quantities of water; and to attempt to tunnel the solid rock was voted impracticable owing to the great depth.

For these and other reasons connected with underground railways the tunnel plan was rejected and a bridge is proposed by the present promoters. The dimensions of the bridge now designed exceed those of any bridge project hitherto suggested for this crossing. As seen by the accompanying illustration the channel span would be 1,130 ft. between centers of towers and 1,100 ft. in the clear between points 25 ft. below the river surface; the clearance beneath the bridge would be 140 ft. In 1890 a careful observation of over 7,000 vessels passing the proposed site of the bridge showed that nearly all of the up through traffic passed along the Canadian shore, and the down traffic near the center of the river. The present plan provides for a span of over 500 ft. on the Canadian side, with the pier on the boundary line and separating the up and down traffic. The placing of an elevation of the Capitol at Washington under the main span of the proposed bridge shows better than figures the real magnitude of a 1,100-ft. span. The main-pier towers would be 317 ft. high.

The present railway ferries and lake navigation are compared to a dangerous grade crossing, with two kinds of traffic, and both of great magnitude, now crossing each other at nearly right angles. It is more dangerous than a grade crossing, because the usual precautions and safety appliances, applicable upon a railway, cannot be used here. The bridge illustrated meets the views of the Chief of Engineers, and has been approved, with two minor amendments, by the Secretary of War. In answer to the demands of lake carriers for a bridge of 2,000 or 3,000-ft. span, and to the objection of the Buffalo Board of Trade to the present plan, it is pointed out that these longer spans as yet only exist upon paper, and with the exception of the Forth bridge, with its 1,700-ft span, this would be the longest railway span in existence. The Memphis bridge has only a 770-ft. opening.



PROPOSED DETROIT RIVER BRIDGE.

THE HYDRAULIC GRAVEL ELEVATOR AT THE CHESTATEE MINE, GEORGIA.*

By W. R. Crandall, Dahlonega, Ga.

The placer deposits of the South, which were the original localities from which gold was mined, have been extensively worked, and to any one now undertaking their development offer many difficulties. The obstacle generally consists of lack of drainage, the deposit being often entirely below the water-level of the adjacent stream, and the remedy must be some means of raising the tailings and water to such an elevation as will allow their discharge into the natural water courses. A type of portable hydraulic lift or gravel elevator, which, I believe, more nearly suits the requirements of the Southern placer deposits than any I have yet seen, is shown in the cuts. Fig. 1 shows the elevator in detail, Fig. 2 the manner in which it is set. The parts are lettered as follows:

A. Cast-iron elbow at the base of the elevator.
B. Wings of vanes, to straighten the water before it enters the nozzle.
C. Nozzle.
D. Air-cap.
E. Air-inlet pipe, to furnish air when the bottom of the discharge pipe is submerged.
F. Studs to support the discharge pipe, and to keep it and the nozzle in line.
G. Cast-iron flanged throat.
H. Discharge pipe.
I. Discharge box.
K. Hood for discharge-box.
L. Adjustable wood-packing around discharge pipe.
M. Discharge flume.
N. Adjustable flume supports.

This elevator at the Chestatee mine, near Dahlonega, Ga., where it has been gradually developed and perfected under the needs of practice, consists essentially of an elbow, A, longer at one side than the other, and coupling by means of a flange to a 5-in. pipe. At the other extremity is a flange into which the nozzle screws, and three studs, F, which support the throat into which the gravel and water enter to be elevated. The throat slips inside the 6-in. lap-welded pipe, H, for discharging into the flume on the bank, from which it may be conveyed wherever desired.

The whole apparatus, except the discharge pipe, may be readily carried by two men. If it be necessary to move the elevator often, to keep up with the drainage, the portable character of the outfit is a great advantage.

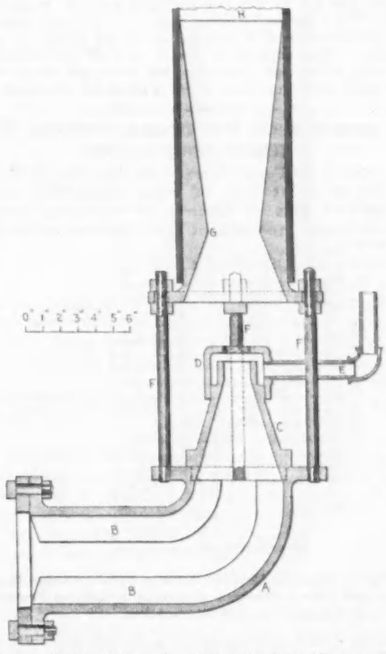


Fig. 1.—Hydraulic Elevator at the Chestatee Mine, Lumpkin Co., Ga. Designed by W. R. Crandall, Superintendent.

At the Chestatee mine the practice is about as follows: The water supply is conducted to the mine through a 9-in. pipe. At a suitable point the water is divided, and a 5-in. pipe conveys that used by the lift, while a 7-in. pipe conducts to the giant. Valves are provided at the tee, so that one or both may be shut off as necessity requires. The lift is set into the slate to such depth as may be desired, and connection is made with the water supply pipe. The discharge pipe is then slipped over the throat and the discharge flume is put in place, the discharge pipe being set at such an angle of inclination as may be necessary to give proper grade to the tailings flume and allow the pipe to extend a few inches through the bottom of the hooded box.

The air-pipe, E, is then screwed into place, and the lift is ready for operation. We govern the depth to which we set the lift into the bed-rock slate by the hardness or softness of the latter. If it be hard, frequent moving is cheaper than cutting slate drains. If soft, we go as deep as the slate will stand without timbering. This we find to be about 7 ft.

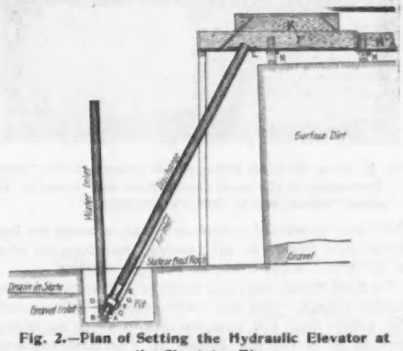


Fig. 2.—Plan of Setting the Hydraulic Elevator at the Chestatee Mine.

A main drain is then started in the general direction of our work, from which laterals are afterwards cut as required; and, at some suitable place near the lift-pit, a box about 6 ft. long by 32 ins. wide is set into the drain at grade, and in this is placed a cast-iron "grizzly" having round holes 2½ ins. in diameter. This catches any rocks which may escape the forkers, and insures that nothing will get to the lift which will not readily pass through the throat, which has, when new, an opening of 3 ins.

*Abstract of a paper presented at the Pittsburg meeting of the American Institute of Mining Engineers, Feb. 20, 1896. Descriptions and illustrations of a similar apparatus in use in Burke Co., N. C., were given in Engineering News, Jan. 16, 1896.

We usually use about 200 ft. of 5-in. pipe in the lift water supply before extending the 9-in. pipe-line; and we often move up 100 ft., dig the pit, reset the lift and get ready for work again in one 12-hour shift with five men.

The lift has a 1½-in. nozzle, discharging through a 3-in. throat into a 6-in. pipe, and lifting an average of 18 ft. vertically with water at about 60 lbs. pressure per sq. in. We use a 1¼-in. nozzle on the giant, and the lift handles all the surface water, probably 50 gallons per minute, and all the dirt and gravel we are able to wash to it. The latter we estimate, from measurements taken at different times, to be about ⅛ cu. yd. per minute of "topping." The quantity of gravel is hard to determine, owing to varying conditions; but it is safe to say that it is all that the amount of water employed will wash.

REQUIREMENTS FOR TENSILE STRENGTH IN CEMENT SPECIFICATIONS.

By J. M. Porter,* Assoc. M. Am. Soc. C. E.

On a recent piece of work embodying some 4,000 cu. yds. of concrete of which the writer had charge, the cement specifications called for,

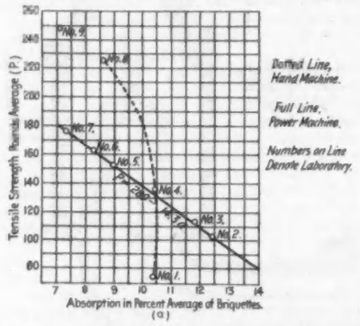


Fig. 1.—Diagram Showing Relation Between Absorption and Tensile Strength of Cement Briquettes Broken by Automatic and Hand Machines.

among other requirements, a tensile strength of 150 lbs. for one cement to three sand mortar at the age of seven days. The first shipment of cement received on the work was sampled and tested and failed to fulfil the requirements for tensile strength and the contractor was so notified. At the request of the cement manufacturers their representative tested the cement with a result about 15% below the result first obtained. The manufacturers again requested that a representative from a certain testing laboratory be allowed to make a test. This request was also granted, and the result obtained was over 50% in excess of the first test and brought the cement beyond the requirements of the specifications. All these tests were made from the same sample of cement, using the same sand, mixed and molded in the same laboratory, and broken by the same machine. The writer knew

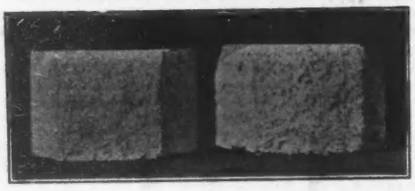


Fig. 2.—View Showing Difference in Density of two Cement Briquettes of the same Composition and Molded by the same Method, but by Different Persons.

that the "personal equation" was a more or less important factor in all testing, but had no idea of its great magnitude in cement testing.

To find what varying results different persons would obtain from the same sample of cement, the writer had ten samples taken from as many barrels of a certain brand of Portland cement. These samples were thoroughly mixed together and portioned into ten smaller samples of average quality, which were sent to ten different persons, with a request that a seven-day tensile test, one to three sand, be made according to their understanding of the method proposed by the Committee of American Society of Civil Engineers. The accompanying table gives the results obtained from nine different persons arranged according to their averages.

*Professor of Civil Engineering, Lafayette College, Easton, Pa.

What value has a tensile requirement in cement specifications under the present method of testing when one person obtains 30 lbs. and another 100 lbs. as a result upon the same sample? The cement which one engineer would accept would be rejected by another under the same specifications. Where do the contractor and cement manufacturer stand in this matter? The writer knows that cement can be made to stand almost any tensile requirement within reasonable limits that would ordinarily be made by varying the method of mixing and molding, but when the mixing and molding are supposed to be done in accordance with a given method and yet the results vary widely, either the method is at fault or the results have no value unless weighed by the varying personal equation of the manipulator.

It may be said that when an engineer prepares his specifications for cement, he knows how much he can obtain from a good cement in the way of tensile strength. If this is the case he certainly must have had one or more brands in mind at the time of writing the specifications. Then why not specify the brands, stating chemical limits, time of setting, specific gravity, etc.? The objection to this method is that a given brand of cement will vary in tensile strength. Does any one suppose, however, that a well-established brand will drop much over 70% from the requirements that an engineer would ordinarily specify? According to the accompanying table the brand could drop that amount before it would be rejected by some other engineer under the same specifications.

The writer had two men in his employ, both equally skilled in cement testing make a tensile test on five briquettes, one to three sand, on the same sample of cement. The tests were made in the same laboratory, the mixing and molding being done at the same time and the same bath was used, thus eliminating all atmospheric and water conditions. The results were to each other as 85 to 100; and if the lower one had been taken the cement would have fallen below requirements, while taking the higher result, the cement would have passed. The question was, which result to adopt? Again, two men employed by the same cement manufacturers and accustomed to making cement tests for their employers, made five briquettes each from the same sample of cement. The briquettes were broken by the same machine and operator with results standing as 58 to 100. All of the before-mentioned tests were made upon a sand mixture of three to one, and it might be said that if neat tests had been made closer results would have been obtained. This brings up the question as to the relative value of sand tests vs. neat tests, in which the writer favors the former as they conform more nearly to practice. A given person skilled in cement testing can obtain results from the same sample of cement under normal conditions using the present method of testing within 5% of the mean value.

The writer knows a cement inspector in one of the larger cities who is frequently compelled to go out on work, take a large number of samples, return to his laboratory with possibly 25 lbs. to 30 lbs. of cement, and then go to work and make 100 briquettes. Does any one suppose the last briquette made received the same work as the first one, or the first one the treatment that would have been given it if a fewer number of briquettes had been required? This is probably an extreme case, but, nevertheless, cements stand or fall upon this inspector's report.

Accompanying the table is a diagram (Fig. 1) showing the relation between the percentage of absorption of the broken briquettes and their tensile strength. The relation of the briquettes broken by power-driven machines is rather striking. The term power-driven is applied to any testing machine which applies the load other than by hand.

Upon examination of the broken briquettes, all of which had been returned, it was noticed that they had varied greatly in density. In a letter accompanying the report from one of the laboratories, it was stated:

> The quartz grains are so nearly of one size that the volume of voids left to be filled by the cement is excessive. If the sand (or quartz) were of graduated sizes the cement would be used wholly for coating the grains and not for filling relatively larger voids. In this case the broken briquettes show clearly that the cement was quite insufficient to fill the voids, as the briquettes are quite open and porous.

The briquettes mentioned were extremely porous, while others were quite dense.

Fig. 2, reproduced directly from a photograph showing a very dense and a very porous briquette, illustrates the point brought out above quite clearly. The most porous briquette is shown at the right, and is from laboratory No. 1. The left-hand briquette is from laboratory No. 7.

The percentage of absorption of the broken briquettes was assumed as a measure of their density, and was obtained by allowing the briquettes to remain in a dry room for two weeks or more, then placing them in an oven having a

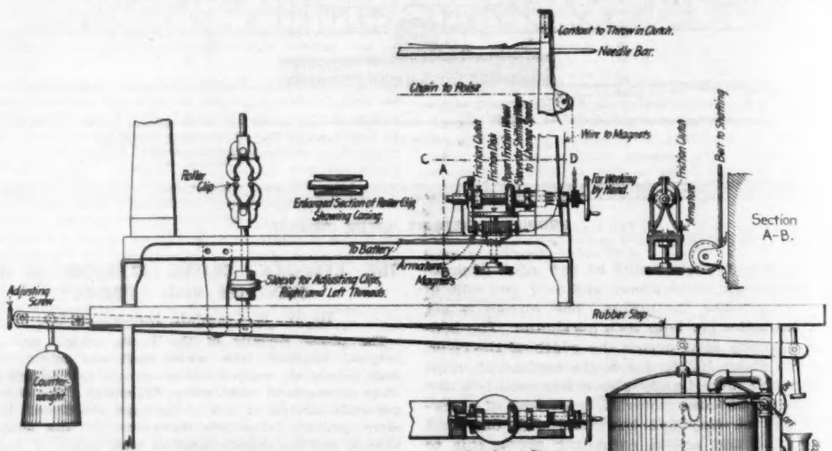


Fig. 3.—Automatic Cement Testing Machine of 2,000 lbs. Capacity; Lafayette College, Easton, Pa.

temperature of 100° C. They were taken out of the oven at the end of two hours and carefully weighed, then placed in water for 48 hours, removed and again carefully weighed. The absorption was computed in per cent. of the original weight and averaged.

The tensile strength of the briquettes broken by power-driven machines, with one exception, follows very closely $P = 280 - 14.3\,a$, where P is the tensile strength in pounds and a the percentage of absorption, obtained as above stated. From this relation, it would seem, if percentage of absorption is any measure of density, that the mortar for these briquettes received about the same mixing, and that the variance in

tensile strength is due to the molding alone. While this may be true for the briquettes in question, the writer does not believe it true in general, as the mixing of mortar for briquettes is too important a factor to be decided one way or another by so few comparisons.

The percentage of water used by the different manipulators in making the briquettes varied 33⅓%, due to the operators' varying understanding of the term "stiff and plastic" in connection with temperature. In one case a decrease of 20% in water gave an increase in tensile strength of 5.2%.

Single molds were decidedly in favor, only two out of nine persons using gang molds. The writer believes it possible to obtain higher results from single than from gang molds, but if both were to be treated the same, the results would differ but slightly. A letter from one of the laboratories stated that results were about the same whichever molds were used. A person having a large number of briquettes to make will find without doubt that gang molds are preferable.

The term "struck off" seems to mean that both sides of the briquette are to receive that treatment; at least, two out of every three operators so interpret it. There is not much doubt but that a given amount of work distributed equally over two sides will give a denser briquette than if one side only received the whole of it. Working both sides of a briquette gives a more homogeneous cross-section, which is as important as uniformity of the several briquettes, particularly when it is remembered that the load in testing is applied at four points.

The placing of the briquette in water flatwise seems to be the favored position. The writer, however, prefers placing them in water on edge, as more surface is exposed to the direct action of the water. The objection to this method is the danger of the briquette changing form under the action of its own weight. The writer never has had any trouble from this cause, nor does he know of any one else who has had any.

Still water for the bath seems to be in almost general use. This is probably due to the difficulty and expense of having running water, which no doubt would be preferred if a choice were given. The practice of using the same still-water bath over and over again cannot be too strongly condemned. The writer knows of laboratories where this is common practice, and where fresh water is added in quantities sufficient only to replace that lost by evaporation. In running-water baths, the supply should be so arranged as not to come directly upon the immersed briquettes. This latter point is also often overlooked.

Power-driven testing machines are decidedly in the majority. The writer believes that hand-driven machines should be entirely abandoned, as it is about all an ordinary mortal can do to handle one crank without being compelled to take care of two. In power-driven machines the writer prefers those applying the load by the weight of water or shot to those applying the load by means of a screw driven by gearing and belts, as he believes the former to give a more uniform rate of increase. Fig. 3 shows the construction of the machine designed by the writer.

The load is applied by water flowing into a tank suspended from the long arm of a very sensitive 15 to 1 lever. The weight of the lever and tank is counterbalanced by an adjustable weight shown on the left. Water is admitted to the tank from a large reservoir on the roof under a practically constant head of 90 ft., so there is no sensible variation of pressure in the stream admitted through a carefully fitted gate valve in the supply pipe. The position of this valve at "on," "off" and all intermediate points is shown by an index attached to the stem of the valve and registering on a dial marked off with the number of pounds per minute applied to the specimen as determined and verified by previous experiment.

When the briquettes break the lever drops a few inches, then the plunger at the right end of the lever enters the pneumatic stop, and the lever and tank are gradually brought to rest. During the fall of the tank and before it comes to rest, a chain attached to the end of the valve stem in the tank is brought into tension and arrests the descent of the valve before its seat stops descending. The opening of this valve allows the contents of the tank to be quickly discharged into a hopper placed upon the floor, and is then carried off through a waste pipe to the sewer. As soon as the tank has discharged its contents, the weight on the left end of the lever brings the lever and tank into the position shown in the illustration, the valve taking its seat during this movement and the machine is ready for another break. The actual load can be applied at from 0 to 80 lbs. per minute, thus giving an increase of stress of from 0 to 1,200 lbs. per minute. The speed generally used is 400 lbs. per minute, and with the valve set for this speed the needle beam will float every time within 1-5 second of the proper time.

The stress on the specimen is measured by a poise traveling on a graduated scale beam, which can be read by means of a vernier to 1 lb. and can be moved automatically or by hand at the wish of the operator. The automatic movement is accomplished by the following described device:

The horizontal disk and its engaged friction wheel are driven continuously by the pulley placed at the lower end of the vertical shaft and belted to overhead shafting. This friction wheel is feathered to a sleeve that runs loose on its shaft and carries a coned clutch that is nominally disengaged from its cone, which is also feathered to the shaft, and can be moved slightly longitudinally on the shaft into contact with the clutch by the action of the vertical lever.

When the needle beam rises, it makes contact through a vertical pin in the top of the frame, which completes an electric circuit and sends a current through the electro-magnet and causes it to attract its armature at the lower end of the vertical lever, which moving to the right engages the friction clutch and causes the shaft to revolve. This shaft operates the sprocket wheel and chain which draw out the poise on the scale beam until the needle beam drops, breaking the electric circuit. Breaking the electric circuit releases the armature and allows the friction clutch to disengage and the poise comes to rest. The friction wheel may be set at a greater or less distance from the center of the disk by turning the capstan head nut, and the chain is overhauled faster or slower, causing the poise to move accordingly. If desired, the poise may be operated by the hand wheel without interfering with the automatic device other than cutting out the circuit. The chain is attached to the poise in line with the three knife-edges of the scale beam, hence the tension in the chain has no tendency to lift up or pull down the poise. This point is often overlooked in designing this detail, not only in cement machines but in testing machines in general. The writer has a cement machine in which the error due to this cause is over 15 lbs.

This machine, as described, has been in almost constant use for eighteen months and has given entire satisfaction. The operator has simply to place the briquette in the clips, open the supply valve, wait until the briquette breaks and then note the reading on the scale beam. The objection to this machine is the space it occupies, requiring a floor area of 7 × 2 ft., and the necessity of a constant head of water.

From the figures given in the table it is evident that the personal equation is a decidedly important factor in cement testing, and before tensile requirements in specifications can have any meaning, a method must be adopted that will considerably reduce or entirely eliminate this factor. With this in view the following requirements are suggested:

(1) Mixing and tempering by machinery, using enough mixture to make a given number of briquettes.

(2) Molding under a given pressure.

(3) Regulation in regard to the bath and manner of placing briquettes in the same.

(4) Abolishing the use of all testing machines applying the load by hand.

Table Showing Results of Tensile Tests of One Part Cement, Three Parts Sand Mortar—Same Sample of Cement—Made by Different Persons in Accordance With Their Understanding of the Method Proposed by the Committee of the American Society of Civil Engineers.

Laboratory.	Tensile strength in lbs. of briquette.							Range in pounds	Ratio of range to maximum.	Ratio of average to maximum.	Water, per cent.	Molds.	Struck off.	How placed in water.	Water bath.	Kind of Machine.
*No.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	Aver.									
1. R. W. Hildreth & Co., New York	68	72	74	78	82	..	75	14	17.1	30.4	12.0	Single.	Both sides.	Flat.	Still.	Riehle, Driven by hand.
2. Washington University, St. Louis, Mo. Prof. J. B Johnson	77	94	108	110	122	..	102	45	36.9	41.8	Not known.	Gang.	One side.	Flat.	Still.	Fairbanks, Johnson's Clip.
3. City of Easton, Pa. H. R. Fehr, City Eng.	106	112	123	..	..	..	114	17	13.8	46.5	10.4	Single.	Both sides.	Edge.	Still.	Fairbanks.
4. Columbia College, New York. Prof. W. H. Burr	125	126	130	137	140	144	133	19	13.2	54.0	10.0	Single.	One side.	Flat.	Still.	Riehle, Driven by hand.
	126	132	138	144	150	153	140	27	17.7	56.8	8.0	Single.	One side.	Flat.	Still.	
5. Chas. F. McKenna, New York	148	150	151	155	160	..	153	12	7.5	62.0	12.0	Single.	Both sides.	Flat.	Still.	Riehle-McKenna Power driven, Rubber clip.
6. Cornell University, Ithaca, N. Y. Prof. F. P. Spalding	155	160	164	166	172	..	163	17	9.9	66.0	Not given.	Single.	One side.	Edge.	Running.	Lever with water bucket.
7. Lafayette College, Easton, Pa. J. M. Porter	171	177	177	178	179	..	176	8	4.5	71.4	11.0	Gang.	Both sides.	Edge.	Running.	Olsen-Porter, Porter clip.
8. Clifford Richardson, Washington, D. C	220	224	226	228	228	..	225	8	3.5	91.2	10.0	Single.	Both sides.	Flat.	Still.	Riehle, Driven by hand, Rubber clip.
9. Booth, Garrett & Blair, Philadelphia, Pa.	240	246	249	250	252	..	247	12	4.8	100.0	12.0	Single.	Both sides.	Edge.	Still.	Olsen, Power Driven, Rubber Clip.
Average	..	..	..	..	..	..	153	17.9	12.9	62.0	10.8	77.8 % Single. 22.2 % Gang.	66⅔% Both sides. 33⅓% One side.	55.5% Flat. 44.5% Edge	22.2% Running 77.8% Still	66⅔% Power 33⅓% Hand

* No. 2, water in bath changed once; No. 5, water not changed; No. 6, flow of water just sufficient to keep it fresh; No. 7, flow of water slight; No. 8, speed of applying load 35 lbs. to 40 lbs. per minute. All molds and sand Am. Soc. C. E. recommended sizes.

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CHAS. W. REINHARDT.....CHIEF DRAFTSMAN.

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The big truss in the new extension of the Waldorf Hotel, which we illustrate this week, represents a somewhat novel development in structural ironwork. In the design of this building it was required that there should be a large ballroom on the ground floor, the floor space of which must be kept free from columns, and this is effected by the use of a large truss carrying the ends of box girders which extend to the wall or abutment columns, these girders in turn carrying the floor beams. The truss extends up through two floors, and being intended only for temporary use, as described in the article referred to, has its posts built to serve eventually as columns, so that the weight is exceedingly heavy. While this truss, supporting about five floors, will eventually be transformed into column construction, the new Astor Hotel (which is being erected on the ground adjoining the Waldorf Hotel) will have still larger trusses carrying permanently about 12 or 14 stories above the great ballroom, these trusses extending up through four floors. One condition governing the design of such trusses is that the members must be so arranged as to avoid interference with corridors, doors and other openings provided for in the architect's plans, and this, together with the necessity of making the height conform to the heights of the rooms, and of providing for the support of the intermediate floors occurring in the height of the truss, makes the design of such structural trusses much more complicated and difficult than the design of ordinary bridge and roof trusses. In the first introduction of the skeleton frame type of construction for buildings, it seemed that the design of columns and floor systems of sufficient strength and stiffness was practically all that was required. The great height to which these structures were carried, however, made necessary a careful consideration of the question of providing sufficient wind bracing and at the same time avoiding the obstruction of windows, corridors, doorways and other openings whose location was fixed. This question has been frequently discussed in our pages. Then the great loads on columns and the necessity of keeping all foundations within the limits of the property lines, made it impossible in some cases to provide the required foundation area for wall or abutment columns, and these columns have therefore in some cases been supported on cantilever trusses resting upon ample foundations placed back from the property lines. Such a construction was adopted in the construction of the American Tract Society Building, New York city, as illustrated and described in our issue of Dec. 27, 1894. The introduction of trusses to avoid the use of columns within a large area of the lower floors of a building, and to permanently carry an immense structure over this area, is the latest and one of the most interesting features in the development of structural ironwork for buildings, although it is not probable that such a system of construction will be adopted in any but a comparatively few special cases.

Thou shalt not cast garbage before swine, nor before any other animal used for human food, says an act introduced in the present session of the Massachusetts legislature. The proposed act is simply a more stringent substitute for a law passed last year which did not include swine among the animals to which feeding of garbage was forbidden, and applied to cities over 30,000, instead of 25,000 inhabitants. The law at present in force, which is a model of brevity and clearness, is as follows:

> Whoever knowingly feeds or has in possession with intent to feed to any food animal, except swine, any garbage, refuse or offal collected by any city of more than 30,000 inhabitants, by contract or otherwise, shall be punished by imprisonment in the jail or house of correction not exceeding 30 days, or by fine not exceeding $50.

City garbage, as collected in bulk at intervals in most cities, is unfit food for animals which furnish meat or milk for human consumption. Offensive decomposition often sets in before it is consumed by the animals to which it is fed. Besides this, it is claimed on what seems to be good authority that garbage-fed hogs are especially liable to trichinosis, a disease sometimes conveyed to man through partially-cooked pork and allied products.

Were such legislation as has been enacted and as is proposed in Massachusetts to be carried out in other states, it would be a great boon to health and decency. Besides wiping out the baneful results of feeding garbage to food animals, it would hasten improved methods of disposal and render the utilization processes more profitable and thus cheaper in their cost to municipalities. Not all the garbage collected is edible, and where a portion of it is fed to animals the balance is almost invariably disposed of in an unsanitary manner. Take away the privilege of feeding a portion of the refuse to hogs and other animals, and it would be difficult to get rid of the whole except by means of crematories or utilization plants. The richest garbage is naturally sought for feeding purposes, and it is just this that brings the most return in the utilization processes. In cities where the garbage is treated by these processes there often arises a conflict between private collectors of hotel wastes and the reguar city contractors. This garbage is not only rich, but is to be had in large quantities unmixed with other matter. The Massachusetts act does not apply here, since it relates only to garbage collected by or for the city. But after cutting off the feeding of all other garbage to animals, and taking out the establishments having no arrangements with private contractors, or not caring to maintain them, it would be comparatively easy to bring the hotel garbage into line so it would be taken to the crematory or utilization plant. Some communities permit no garbage to be hauled through the streets without a license, and most others might establish such a practice, thus controlling the hotel garbage as well as that from other buildings. In some cities hotels have contracted privately for garbage removal because the city service was defective, or wholly lacking, or was not given without compensation. In many such cases the proprietors would readily turn the stuff over to the city or its agents if proper disposal without expense would follow.

The day will come when not only the present but also the proposed Massachusetts law will be in force in many other states.

Eight years ago, soon after the late A. M. Wellington became one of the editors of this journal, the sub-title of Engineering News was changed from "American Contract Journal" to "American Railway Journal." A few months previous to this Mr. M. N. Forney brought out a paper which he called "The Railroad and Engineering Journal," which he founded on the ashes of two old periodicals, "The American Railroad Journal" and "Van Nostrand's Engineering Magazine," which were purchased by Mr. Forney.

Our adoption of the sub-title "American Railway Journal" was resented by Mr. Forney, and he brought suit against the Engineering News Publishing Co., for an injunction to prevent its further use, claiming that it infringed his rights as purchaser of the periodical "American Railroad Journal." The New York Supreme Court refused the injunction and its decision was sustained on appeal. The following is quoted from the Court's decision:

> The plaintiff's (Forney's) publication had but a limited circulation and there is an utter absence of evidence even tending to show actual confusion in any instance from the claimed similarity in name; while the titles as printed, instead of indicating possibility of error from defendents use of the words "Railway Journal," rather show probable confusion and mistakes from plaintiff's use of the term "Engineering." . . .
>
> The principle is that there must be an adaptation of plaintiff's title, either exact, or to an extent sufficient to show an appropriation of words producing similitude in the titles themselves, or from well established popular designations.
>
> Decree for defendant with costs.

The whole decision was printed in our issue of July 5, 1890, and we will now explain why we have found it necessary to take up space with this ancient history: Mr. Forney, after making various changes in the name of his publication, has recently consolidated it with "The National Car and Locomotive Builder," and issues as the product of the union a monthly which he calls the "American Engineer, Car Builder and Railroad Journal." In his second issue he makes note of the birth of an infant journal in Kansas City, which has adopted "Engineering News" as a part of its title, and says:

> The appropriation is, however, regarded in this office with equanimity, for the reason that the journal which has thus been despoiled of its good (?) name was guilty of a similar act some years ago in adopting "Railway Journal" as its sub-title, which is substantially the name under which this paper had been published for over 50 years, and which is still retained. The court refused to right the wrong, and our friends in Kansas City can now appeal to its decision, if they are disturbed in the possession of that which our sense of integrity compels us to admit is not fairly theirs, any more than "Engineering News" of New York is entitled to use "Railway Journal" as part of its title.

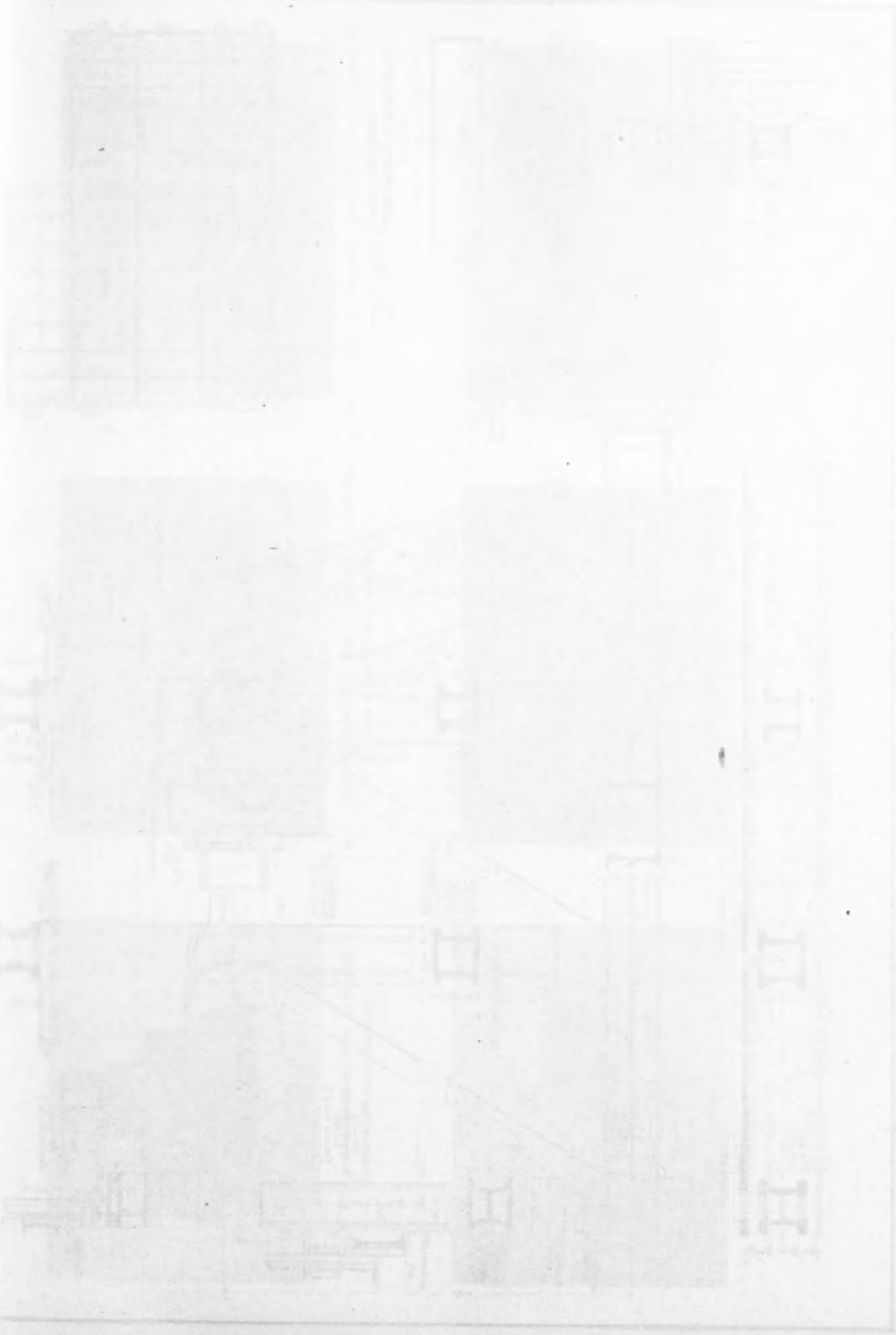
We had supposed that Mr. Forney had long ago seen the folly of his claim of injury, concerning which he appealed to the courts; but he says in the quotation above cited: "The courts refused to right the wrong." It appears, therefore, that he is still of the opinion that our adoption of the sub-title "American Railway Journal" infringe in some manner his rights.

Mr. Forney must admit, however, that the court decision above noted settled any question as to our legal right to use this sub-title, for that is legal which the courts decide to be legal. His contention is, then, that there was a miscarriage of justice in this case, and that Judges Beach, Van Brunt, Brady and Daniels, of the Supreme Bench, were all in error in their decision against him.

Very well, we will meet Mr. Forney on his own ground. He contends, to use his own terms, that we have been "guilty" of a "wrong"; we now desire him to show us each and every instance in which his journal has suffered in income or reputation from our use of the sub-title above noted, which we have now continued for eight years, and we agree to make good to him each and every such loss. If he is unable to do this, we trust that "sense of integrity" to which he refers will lead him to consider in all fairness whether his assertion that we have done him an injury is not one which he should justly withdraw.

It will be noted that the Judge in his decision predicted that confusion would be more likely to rise from Mr. Forney's adoption of the term "Engineering" than from our adoption of the sub-title "American Railway Journal." Exactly this thing has happened. We can recall several instances where letters intended for our journal have been delivered to the other through confusion of our main title with his; but we can recall no single instance of such a thing through confusion between our own sub-title and that which Mr. Forney so jealously prizes.

7 MAR 1894



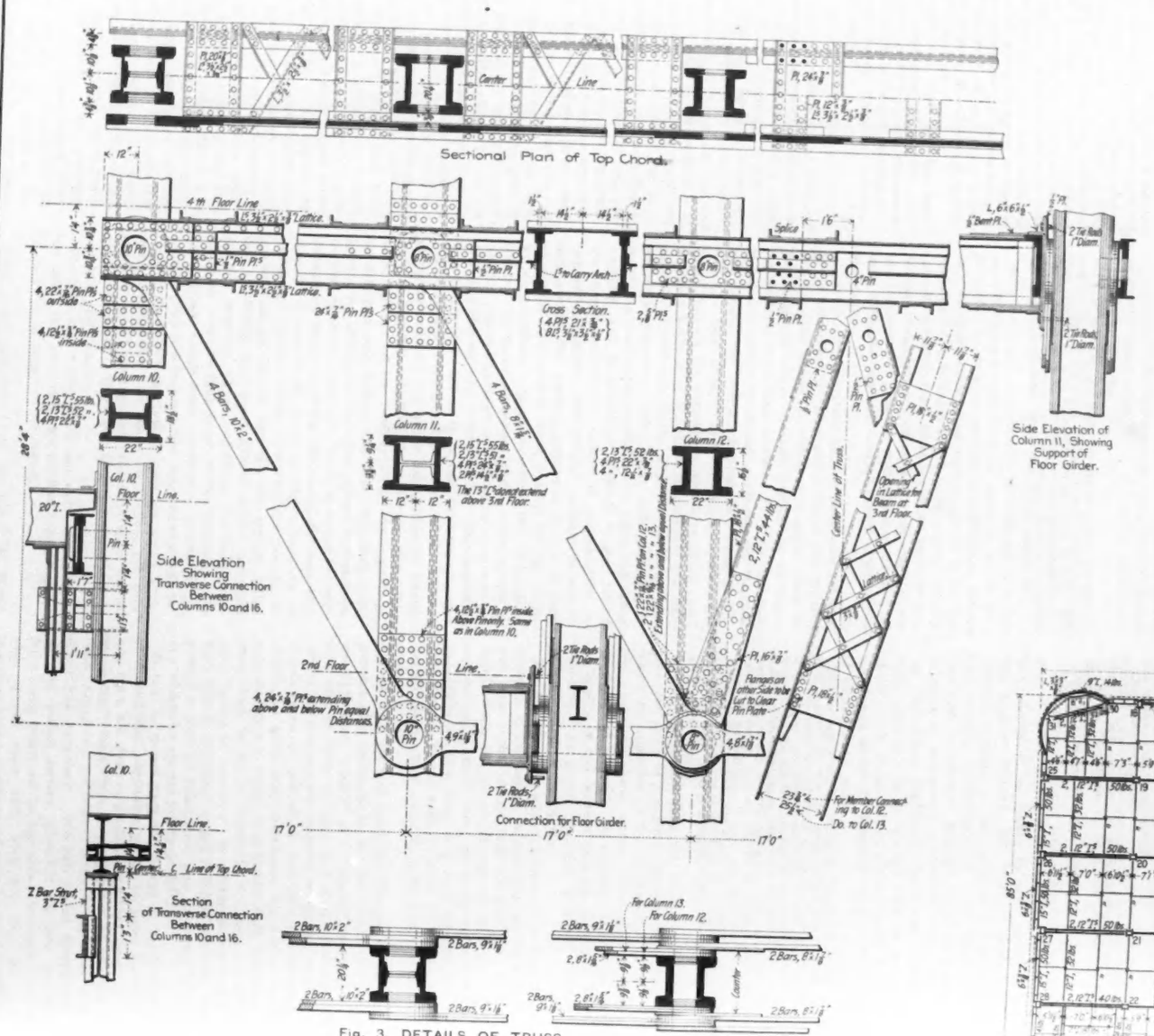

Sectional Plan of Top Chord.
Side Elevation Showing Transverse Connection Between Columns 10 and 16.
Section of Transverse Connection Between Columns 10 and 16.
Connection for Floor Girder.
Side Elevation of Column 11, Showing Support of Floor Girder.
Cross Section.

Fig. 3. DETAILS OF TRUSS.

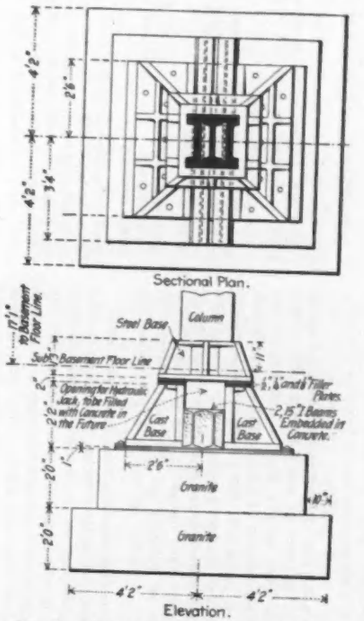


Fig. 4. ADJUSTABLE FOUNDATION FOR COLUMNS.

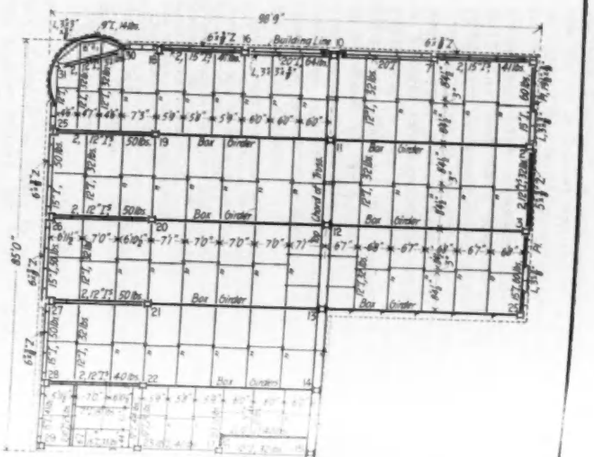


Fig. 1. PLAN OF FRAMING OF FOURTH FLOOR SHOWING POSITION OF TRUSS.

TRUSS FOR CARRYING FLOORS IN THE WALDORF HOTEL EXTENSION, NEW YORK CITY.

H. J. Hardenbergh, Architect.

Fig. 7. PLAN OF FRAMING OF FOURTH FLOOR SHOWING POSITION OF TRUSS.

TRUSS FOR CARRYING FLOORS IN THE WALDORF HOTEL EXTENSION, NEW YORK CITY.

H. J. Hardenbergh, Architect.

Purdy & Henderson, Consulting Engineers.

Fig. 1. LEWIS GASOLINE MOTOR CARRIAGE.
G. W. Lewis, Chicago, Designer.

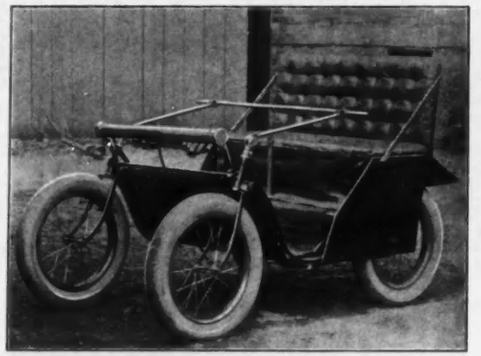


Fig. 2. KANE-PENNINGTON GASOLINE MOTOR CARRIAGE.
Thos. Kane & Co., Chicago, Builders.

Fig. 3. BENTON HARBOR GASOLINE MOTOR CARRIAGE.
Benton Harbor Motor Carriage Co.,
Benton Harbor. Mich., Builders.

Fig. 4. DALEY GASOLINE MOTOR CARRIAGE.
M. H. Daley, Charles City, Iowa, Designer.

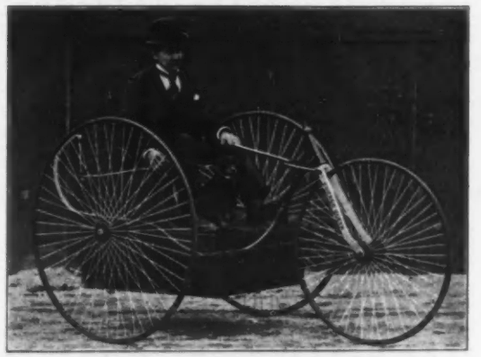


Fig. 5. SIMONS COILED SPRING MOTOR CARRIAGE.
W. A. Simons, Chicago, Ill., Designer.

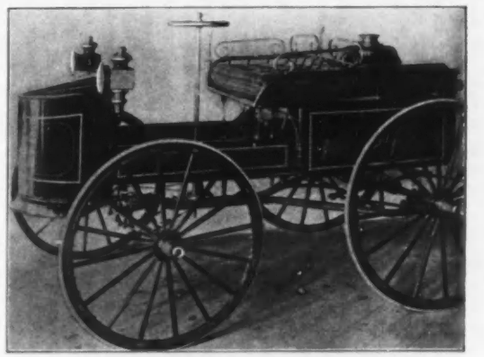


Fig. 6. SHAVER STEAM MOTOR CARRIAGE.
Joseph Shaver, Milwaukee, Wis., Designer.

SOME RECENT AMERICAN MOTOR CARRIAGES.

THE POSSIBILITIES OF MECHANICALLY-PROPELLED VEHICLES FOR COMMON ROADS.

The possibility of developing the mechanically-propelled road carriage into a thing of real service, and the results which may be reasonably anticipated from such a development if it can be accomplished, are questions which are being more generally and more seriously considered at the present time than ever in the past. The correctness of this statement is attested by the motor carriage races of 1894 and 1895 in France, the late recent exhibition of such vehicles in England, and finally by the interesting contest held in Chicago, which has been described in this and the previous issue of Engineering News. If further proof is needed, it may be deduced from the fact that a number of manufacturing firms in Germany, France and America stand ready to-day to build motor carriages to order, and that trained, practical engineers are putting their minds to the design and construction of such vehicles. In this last respect conditions have changed materially within a short time. The vagaries of crack-brained inventors may still be found in quantities; but these are being gradually weeded out and relegated to the limbo of our patent records by the work of conservative engineers and manufacturers.

It is for these reasons that we have collected the information relative to American motor carriages which is reviewed so fully in this issue and our issue of Feb. 27. It is the purpose to consider here the possibilities of motor carriages as a desirable, efficient and safe means of conveyance for persons and goods. Such a consideration naturally divides itself into two questions: (1) To what sphere of usefulness is such a vehicle best adapted, and what will be the character and conditions of its work there? and (2) in what direction had we best work in design and construction to fulfill these conditions. It will be seen that it is tacitly assumed that the motor carriage is mechanically practicable under certain conditions at least. This assumption cannot, we think, be successfully disputed with any reasonable interpretation of the words and with careful attention to the work already done in this and foreign countries.

The sphere of usefulness to which the motor carriage is adapted will naturally be defined differently by different persons, and generally it will be made too broad rather than too narrow. This is especially likely to be the case with the general public—we have already had daily newspapers substituting stage lines of motor carriages for suburban electric railways—but even the generally more thoughtful engineer is not always free from rash statements on this point. For these reasons it is advisable to develop at some length the factors which under present conditions limit the sphere of usefulness of motor carriages. It, of course, stands to reason that as conditions improve these factors will be eliminated one after another, and the sphere of usefulness will be correspondingly enlarged.

The motor carriage, in order to be generally adopted in place of the horse, has got to prove its desirability over vehicles moved by horse power under the great majority of conditions which accompany traffic on public roads; on the dirt highways of the rural districts as well as the paved streets of our cities. Can it demonstrate this desirability under present conditions?

It is manifest to the engineer that power applied to the rims of the wheels of a vehicle depends for its efficiency very much more upon the nature of the roadbed than does power applied as a pull to the front end of a vehicle. George Stephenson 60 years ago demonstrated the fact that in order to run a locomotive successfully you must first provide a proper roadbed, and railway engineers have recognized that fact ever since. The layman who rides a bicycle and doubts the relative efficiency of power applied to the rim of a wheel and hauling power has only to try to ride his machine through 6 ins. of mud and then get off and note with how much smaller an expenditure of muscle he can haul the bicycle equally loaded through that mud.

It is manifest that the nature of the roadbed, or perhaps, better, the track, plays an important part in the efficiency of the motor carriage, the more smooth and even the track the greater the efficiency. When we couple this fact with the fact that the keeping of horses is more expensive in a large city than it is in the country it is a logical conclusion to assert that the motor carriage will be first utilized on the comparatively smooth city streets and last adopted in the suburban and rural districts. There are other reasons than poor roads why the motor carriage will be slow to come into use in the country, but if there were not, the poor roads would be a limiting factor alone. For example, we may refer to the struggles of the R. H. Macy & Co. motor carriage along the country roads of New York state in its attempt to run from New York to Chicago to participate in the Chicago races. It was found impossible to run the carriage without frequent breakdowns and stoppages, and the attempted journey was abandoned; but this same carriage showed much better success in traveling through a foot of slush and mud overlying the Chicago pavements, although it finally broke down in this work. The behavior of the other motor carriages in the Chicago road race is also instructive on this point, for bad as the roads were over which that race was run, they could not compare with the ordinary country roads in spring and fall.

The conditions of road traffic in the country districts, as has already been noted, are not such as will induce the rapid use of the motor carriage even if the poor roads did not prevent its economical employment. By far the larger part of the hauling is done by the farmers' horses in taking farm produce to the railways and bringing supplies back to the farm. Traffic by regular teamsters who do nothing else is very limited to-day, and travel for social and business purposes, not entailing the hauling of freight, is confined mostly to the farmers. Now the farmers must have horses to do their plowing, cultivating and harvesting, and moreover they can use these horses, when they could be doing little else, to haul their produce and to transact their social and business calls. It is not until the motor carriage can show its economy and advantages over the farmers' horses under these conditions, that farmers will buy and use them, even where there are good roads to permit of their use.

We may now turn to the opposite extreme and consider the conditions of vehicle traffic in the large cities. It is evident at once that here we find the best conditions of roadbed to be found; not the best that might be desired, be it noted, but the best that actually exist. This statement demands a reasonable interpretation on broad grounds. The conditions of traffic are exactly the reverse of those in the country; it is imminent and continuous; the butcher and baker must go their rounds in winter and in summer; the express and freight wagons must deliver their goods each day; the cab and omnibus must be ready to move at once and continuously if desired; the work is work that has to be done at a definite time and cannot be postponed, and lastly the horse is used solely to do this work, and is no longer needed if some other motive power is used to do it. If the grocer has a motor carriage to deliver his goods, he does not need a horse, but if a farmer has a motor carriage to haul his produce to market, he must nevertheless have horses to do his plowing.

Enough has now been said, we think, to show that the mechanically-propelled road carriage may be a very useful and desirable thing under certain conditions, but that it is not equally useful and desirable under all conditions. To put the same idea in other words, certain existing natural and industrial conditions limit the field in which the motor carriage can be used to advantage over present methods of doing the same work. We have not thought it necessary to elaborate the sentimental conditions which will always make some men prefer a horse to a benzine motor to haul themselves or their goods; nor is it necessary for obvious reasons to calculate the median line between the conditions most favorable to the motor carriage and those least favorable to it, at which the motor carriage fails to be practicable. The meaning of what is said above should not be misinterpreted. We are far from concluding that conditions will always be such as to confine the use of the motor carriage to the large cities, but we do think that its first use on a broad scale will be in the large cities, and also that its greatest ultimate usefulness will be developed in city traffic.

Admitting that the first general use of motor carriages will be in our large cities, we have, in designing such vehicles, to know the conditions of traffic in large cities. What speed of travel does this traffic demand? What loads will have to be carried? What is the average distance of haul? What is the character of roadbed and gradients? Unfortunately exact figures are not available, but from our general knowledge of conditions bearing on these questions we can obtain sufficiently correct answers for broad general conclusions. The attempt will be made further on to demonstrate why this inquiry is necessary.

It is evident that speed, load and length of haul will vary with different classes of traffic, and it is also evident that roadbed and gradients will differ in different cities, but will remain constant for all classes of traffic in the same city. There will be cases in which it may be advisable to design motor carriages to meet the special conditions of pavements and gradients obtaining in the particular city in which they are to work, but ordinarily this will not be necessary. As a general rule the conditions of pavement and gradient do not differ so much between one city and another, but that a motor designed for average conditions can overcome the exceptional conditions by reducing load and speed. In other words, the motor carriage must meet such conditions just as they are met to-day by horse power.

Speed and load may be considered together, for they vary together with different classes of traffic as city traffic is actually conducted. The cab and carriage must have a relatively high speed and small load, as compared with an express or delivery wagon, and the latter vehicles a correspondingly high speed and small load as compared with a truck for hauling heavy freight. The usual length of haul differs along much the same lines, the express wagon traveling on the average more miles than the freight truck each working day. But even with cab and omnibus traffic the speed is not very great nor is the haul very long. Hardly ever is it possible for a cab to travel faster than eight or ten miles per hour in the most open streets and in the congested business streets the speed must be much slower to prevent collisions with other vehicles and with pedestrians. According to reports from cab drivers and the keepers of livery stables, the average distance traveled by their vehicles each day is not over 35 miles. It is reasonable to assume that the distance traveled daily by delivery and express wagons does not exceed this.

It may be argued that with the general use of motor-driven carriages, these speeds and hauls may be increased; but it would hardly appear that this increase could amount to much. In the business streets, with their hurrying streams of pedestrians and vehicles crossing and recrossing, stopping and starting, turning into and out of the side streets in an endless procession, the speed of vehicular traffic cannot be much greater than it is now without greatly increased danger of collision. In the more open residence streets faster speed may be possible, but even here the ground covered by a delivery wagon will not be much greater, for the time lost in stops to deliver the goods will not be decreased at all. Under most conditions of city travel increased speed means increased danger.

Very little has been said so far regarding the application of mechanical motors to vehicles for pleasure and recreation, or for purely personal use only. The reason for this is quickly stated. Such traffic forms a very unimportant part of the whole traffic, both in its amount and in its value to the industrial life of the community, and the motor carriage to be of the greatest good must be applicable to use by the grocer and expressman and cab driver and to other common everyday employments.

We may now recapitulate briefly before going further. (1) The motor carriage will be of greatest use when applied to mercantile purposes and the greatest value of its development to the people

lies in such an application. (2) For ordinary mercantile purposes great speed and great length of haul are not generally desired. (3) Mercantile traffic in cities divides itself broadly into classes, each class having different conditions of speed and loading from the others.

The motor carriages thus far designed, with possibly a few exceptions, have been designed for passenger uses and not for mercantile uses. This is natural enough in the infancy of their development, but at the same time it should be borne in mind that the greatest utility will be found in other directions. The Chicago "Times-Herald" appeared to grasp this fact when it placed "practical utility" as the basis upon which its premiums should be awarded. On the other hand the "Cosmopolitan Magazine" of New York has failed to perceive it in basing its premiums for a race to be held next May so that speed counts 50 per cent., simplicity and durability 25 per cent., safety and economy 15 per cent., and cost 10 per cent. The effect of the work of the Chicago journal was to develop a machine useful to the public, that of the New York journal will be to develop a racing machine.

This is especially to be deplored, for the average inventor of a motor carriage is already inclined to place speed as the highest goal to be reached. To secure the information upon which our descriptive articles are based, we mailed a list of some twenty questions to every American inventor of a motor carriage of whom we could learn, and whose vehicle appeared to promise anything of merit. Some 40 per cent. of these inquiries were answered, and the information gained was somewhat curious and withal instructive; but owing to its incompleteness and the impossibility of tabulating and summarizing it, only part of the information has been given in our articles. The maximum speeds given ran from 25 miles to 45 miles per hour, and in no case did our correspondents fail to give the speed, although they often failed to mention the manner of developing and applying the motive power. Another instructive fact developed by these answers was that a great proportion of the vehicles were hardly more than the patching together of the first motor and four-wheeled "buggy" at hand. In other words, the construction of their motor carriage had not been studied as a problem in mechanical design; as, for example, the design of a railway locomotive is studied by an engineer. Gasoline engines were the motors generally used, electric motors came next, and then followed steam, coiled springs and compressed air in about the order named. Generally the vehicle was stated to be in the form of a buggy, phaeton or surrey, and only two instances were found where mechanical power had been actually designed to be applied to a shop keeper's delivery wagon, and in one of these the vehicle appeared from the information to have been imported. It is not to be presumed that the information obtained by us covers all the motor carriages of American make, but it is certainly complete enough to show the general status of the development of such vehicles.

It seems to us that two general conclusions may be drawn from the foregoing discussion and the descriptive articles: (1) The application of mechanical power to the propulsion of certain classes of vehicles for common road traffic is no longer a question of possibility, and (2) there is great need to study the limitations and conditions of actual operation confronting the development of motor carriages and especially to study their design on a mechanical basis with a view of adapting them best to these limitations and conditions.

It is not the purpose to enter into the details of motor carriage design here but a few of the features deserving of especial attention in such designing may be touched upon. It has already been shown that the motor carriage should be designed so as best to adapt it to the work it has to do. A vehicle for omnibus or cab uses must be designed so as to be especially adapted to do the work a cab or omnibus is called upon to do. Safety and ease of manipulation of a motor carriage must go hand in hand with its adaptability to its duties. The importance of ease of manipulation especially must not be overlooked, for it is through defects here that the greatest danger will come, and not from explosions or fire. In the Chicago race, over comparatively open roads, several collisions resulted from the failure of the steering and stopping devices or the inability to make them operate quickly and effectively. A horse will nearly always exercise his intelligence to avoid running into obstructions, even if his driver is careless, but the mechanical motor has no intelligence but that of its driver to regulate it. Simplicity of construction is another important feature. The mechanism must not be such that it is liable to get out of order or such that when it does fail it will be beyond the ability of the ordinary man to repair sufficiently well for temporary purposes. The noise, odor and vibrations from the machinery must not be offensive. Durability and reasonable cost are also important items to be looked after. The nearer to perfection in all these respects that the motor carriage approaches, the broader will be its usefulness.

LETTERS TO THE EDITOR.

The Mississippi River Navigation Improvement.

Sir: In your issue of Feb. 6 a letter is published on "The present aspect of the Mississippi River Navigation Improvement," which is so full of misstatements, unintentional, no doubt, that it should not be allowed to pass unnoticed.

In the first place, the Mississippi River Commission has nothing to do with the improvement of that part of the river lying between St. Louis and Cairo, but is confined by existing laws to the river between the mouth of the Ohio and the Head of the Passes. Whether this is good policy or not, Congress, and not the Commission, is responsible for it. The greatest obstructions to navigation lie between St. Louis and Cairo. Below that point there have been several seasons in the past 20 years when there has been a navigable channel of more than 8 ft. without any dredging or other artificial aids.

So far, then, the "support of a movement of this kind" does not necessarily involve a "want of confidence in the methods of the Commission," as the bulk of the work is to be done above where its jurisdiction begins.

There is another point bearing on this question which is important. Section 4 of the Organic Act creating the Commission says: "It shall be the duty of said Commission to take into consideration and mature such plan or plans and estimates as will correct, permanently locate and deepen the channel and protect the banks of the Mississippi River, prevent destructive floods, etc., etc." This was, very naturally, held to mean that temporary expedients like dredging were not contemplated by Congress. After several years of work designed to permanently locate and deepen the channel, it was found that the mighty river was not so easily conquered, and that permanent improvement was a work of far greater magnitude than had been conceived by the most conservative engineers. It was learned by costly experience that flimsy structures put in to obstruct the current did induce deposit, but were very soon destroyed, and it taxed the ingenuity of the most skillful engineers to build structures that would resist the powerful influences that constantly menaced them. There was no precedent for work of such magnitude under such conditions, and much time and money was necessarily spent to gain the required experience. This work was largely confined to two reaches, Plum Point, 150 miles below Cairo, and Lake Providence, 540 miles below Cairo. A large amount of revetment work was also done at various other points; and more than one-third of the money appropriated was devoted to building levees to "prevent destructive floods" and aid in the general work of improvement.

It may be said in passing that the two reaches above named were considered as the very worst places below Cairo. The bars in both these reaches often shoaled to 4½ ft. before the improvement work began. At no time since the improvements were well under way has there been any serious hindrance to navigation in either one of these reaches.

These efforts made it apparent that permanent improvement must necessarily mean a large expenditure of time and money, and the men at the head of the steamboat interests at St. Louis appeared before the Commission and urged measures of temporary relief, such as portable jetties, dredging, and countless other devices. They were met with the statement that the Commission was confined by law to permanent works. The situation, however, grew more desperate, and steamboatmen became more urgent and carried their appeals before Congress, and finally the Commission recommended an allotment for dredging, which was approved by the Secretary of War.

It is altogether too much to say that prior to the appointment of Col. Flad "no civil engineer exerted any marked influence upon the policy or work of the Commission" when we remember that Captain Jas. B. Eads was an active member for four years, and Major B. M. Harrod has been a leading worker and a potent force in framing the policy of the Commission from the day of its organization to the present time.

Col. Flad needs no eulogy from Prof. Johnson. He is too well known among the greater lights of the engineering profession as a man of unusual ability and extraordinary energy, and he is held in the highest esteem wherever known. His career forms a very creditable part of the history of the engineering profession in America, and all are ready to do him honor. To know that he is connected with a work is to know that his best energies are unstintingly devoted to it.

It will be recognized from what has been said that the idea of dredging clearly came from the agitation of steamboat men. When the Commission concluded to test the efficiency of dredges, a committee of two was appointed to take general charge of the matter. Each member of the dredging committee prepared several alternative plans for a dredge and their studies finally resulted in the experimental dredge "Alpha." The actual work of plans, contract and construction was in the hands of the Engineer officer in charge of the First District, who was not limited to "mere draftsmen with no engineering ability." The district officer acted under the direction of the Committee on Dredges, and the result was a dredge, each end of which represented the idea of different members of the committee as to what the dredge should be. As it turned out, the pump of one end and the suction of the other failed to meet expectations, and the present dredge "Alpha" is the result of this compromise.

The "lack of hearty support" by the Commission is hardly borne out by the statement a little further along that allotments amounting to $700,000 have been made for "this experimental work and the building of new dredges." The amount actually expended in dredging experiments and experimental dredges to Dec. 31, 1895, is about $187,000. All allotments are made on the approval and recommendation of a majority of the Commission, and the fact that allotments have been made is of itself sufficient evidence of "hearty support in the preparation of an experimental dredge," and it follows that the existence of two dredge boats at this time proves that there is no foundation for the broad intimation that only one member of the Commission is in favor of dredging. That the Commission should hesitate to endorse dredging as the only remedy was but natural. The most enthusiastic advocate of dredging did not feel at all sure that the channel, once opened, would maintain itself long enough to justify the expense of opening it.

This was the only part of the problem about which there were serious doubts. The principal feature of the dredge, a centrifugal pump, was not novel or new except in its dimensions. The arrangements of floating discharge pipes and other details was, in the main, new. Other features of construction had been previously used on a smaller scale in many other places. The mechanical designing and construction of the dredge was at no time the most important item in the solution of the dredging problem. Nothing short of actual experiments could settle the question of efficiency of dredges, no matter how great the professional skill of those who now see, after the problem is solved, that a navigable channel can be maintained by dredging. If it is true that the success of dredging is fully demonstrated, as Prof. Johnson says, then it follows that the bait of "no cure, no pay" has no value. It is quite evident that the contractor should have a liberal profit out of the million dollars annually received. That is to say, the work according to his estimates will actually cost considerably less than that sum. There is no good ground for assuming that they can do it cheaper than the Commission, and it is hardly fair to assume that Congress or the public cares to put a snug profit into the pockets of the contractors. Since the problem has been solved by the efforts of the Mississippi River Commission with the money supplied by the Government, it is only reasonable that the Government should profit by utilizing the experience gained by its engineers and using the dredges which are now ready for active work next season.

If Congress will appropriate $1,000,000 per annum for 20 years for the purpose of dredging, no "division of opinion" among the members of the Commission will prevent spending the money in the most judicious manner according to the experience already gained and to be acquired as the work progresses. There is no ground whatever in all this for the statement that "we may well conclude that a private contract offers greater assurance of success" when "the methods they (the contractors) would employ" are doubtless the same which the "Commission has now shown to be practicable." It must be clearly shown, beyond the shadow of a doubt, that the work can be done better and cheaper by contract, before Congress will be justified in making such a change. If that can be done, all good citizens should heartily approve of having the work done by contract. In this view of the matter it is, of course, assumed that the sole object aimed at is to accomplish the desired results at the least cost to the Government.

Vicksburg is 780 miles, not "900 miles" from St. Louis, and it would require a very large force under the Government to watch the progress of the contract work, and this would add a very material amount to the mil-

lion dollars proposed in the contract. If Congress decides that the work is to be done by contract, then it should be thrown open to the public and let to the lowest bidder. In that event it would be best to divide the river up into suitable divisions or districts and receive bids on any part or the whole. This would give an opportunity for those who have special devices to show what there is in them.

The responsibility of the contractor as to damages to lands by contraction works caused by erosion induced by their jetties or dredges must be very carefully and definitely outlined. To those who are most familiar with the problem, it seems clear that the abandonment of works to "correct and permanently locate the channel" and to "prevent destructive floods" would be a very grave mistake. The money already expended on works and plant would be lost, and after 20 years of dredging the condition of the river would be the same as it was before any work was done.

A far better alternative would be for Congress to extend the jurisdiction of the Commission to St. Louis and add to their duties as laid down in the organic act quoted above, that of maintaining a channel during the low water season by means of dredges or other suitable devices. To do this ample means should be provided. Let Congress decide how much an improved river with good navigation at all times would be worth to the country and how much they would be justified in paying for the improvement, and then appropriate as large an amount annually for a period of, say, 20 years, as could be judiciously expended.

If it can be demonstrated that better "professional assistance" than that afforded by the present Commission can be obtained, then ample remedy may be found by reorganizing that body. Professor Johnson intimates that the people of the Mississippi Valley have lost confidence in the work of the Mississippi River Commission. This is a remarkable statement in the light of the fact that at the river convention held at Vicksburg last October, the delegates from more than 13 states, covering the entire length of the river, voted a unanimous and hearty endorsement of the Commission and its work. Even the commercial bodies which are endorsing the scheme of dredging by contract and the promoters of this scheme themselves all proclaim themselves the friends of the Commission and disclaim any desire to oppose or hamper it.

Professor Johnson says of the Commission: "They have always been more or less divided in their views as to the proper expedients to employ." Considering the intricacy and magnitude of the problem with which they have had to deal, a unity of opinion would have been much more remarkable. It is not at all to their discredit that they have held different views or even that they should change their views as experience developed new difficulties, new facts.

It is extremely improbable that, even with "the best engineering advice" and "the proper professional assistance" a board of seven honest, intelligent men could be selected to undertake the improvement of the Mississippi River who would not be more or less divided in their opinions. In this problem engineering experience is a much more valuable factor than "advice" or "professional assistance."

The important feature of this agitation is not whether the work shall be done by the Commission or by contract. The public cares little for either one or the other, except so far as they may be instrumental in securing the best results for the least money. The engineering profession and the public at large will be amply satisfied if the action taken by Congress results in that judicious and proper expenditure of money which will give the relief that the navigation interests of this great commercial highway deserves.

J. A. Ockerson, M. Am. Soc. C. E.

St. Louis, Mo., Feb. 17, 1896.

(In accordance with our usual rule we delayed publication of the above letter until a proof could be submitted to the writer of the article criticised and an opportunity given him to reply. We append his letter as follows:—Ed.)

Sir: Replying to Mr. Ockerson's communication, I have no desire to engage in a controversy on this subject, my former letter having been written only for the purpose of putting, in a general way, the present status of the Mississippi River improvement work before the engineering public. If it contained any misstatements I was not aware of the fact and can but regret it. Concerning the true evolution of the first suction dredge, the "Alpha," however, I think I must stand by my former statement.

I did not mean to convey the idea that Colonel Flad was the first one to propose dredging sandbars, for it is well known in this locality that river men have long claimed that this was the only practicable method. I did mean to say (and did say, I think,) that Colonel Flad was the first person to find a practical method of doing it.

I was early supplied with a full set of blueprints of the working plans of that dredge, and they are all signed by Colonel Flad. I had numerous conversations with him on the subject, and frequently visited the boat when it was nearing completion at St. Louis. The only parts which failed to succeed were those which he accepted under protest, or which were added as an alternative scheme at the instance of other members of the commission, and which he had no confidence in. Thus one of the Allis engines proved too unsubstantial for the service, the chief engineer of the works, Mr. Edwin Reynolds, being on sick leave at the time they were furnished. This was the "pump at one end" referred to by Mr. Ockerson. The "suction at the other" end, referred to by him as having failed, was the alternative drag-suction at the stern of the boat, such as had been employed in the New York Harbor, and which was to be drawn over the top of the bar, cutting off at most a thin slice of some 6 ins. each trip. This scheme Col. Flad always repudiated as being no part of his design. While it might work in comparatively still water, with a smooth bottom, it should not have been expected to succeed in a rapid current, where the sand is being rolled along the bottom, forming "sand-waves" several feet high, and which are known to move down stream some 15 to 20 ft. a day. A cut here, to remain open, must have depth enough to create an independent accelerated current of its own, which will carry out all the sand which of necessity will be drawn into such a cut. A shallow cut would be filled up and obliterated as fast as excavated.

Neither did the "engineer officer in charge of the First District" have anything more to do with the design and construction, as I understand it at the time, than simply to transact the business and pay the bills. And if the other "member of the dredging committee prepared several alternative plans for a dredge." I venture to assert that he never presented any of them either to the committee or to the commission, and if I am wrong in this I hope Mr. Ockerson, who is in a position to know, will correct me.

The present attitude of the commission on dredging is the direct result of the great success of this experimental boat and of the attitude of the St. Louis River interests in bringing forward a proposition to do the work under a guarantee of complete success each year or to receive no pay for that year. I claim also that it is the proper function of the commission to undertake the experimental work, and to prove the adequacy of a new scheme of improvement and to bear the expense of such experiments, but that having shown the practicability of the plan to then let the work out to a private company by contract, as the most business-like way of doing the work.

When the St. Louis parties who first asked for this franchise appeared before the Rivers and Harbors Committee of Congress, Feb. 15, 1896, they were informed that all such work had to be advertised and let to the lowest bidder. They at once assented to this arrangement and they are now demanding, just as vigorously as before, to have the improvement let out in this way, because it is their only hope of getting an open channel. They have lost confidence in the methods of the commission as to the so-called "permanent improvement," and they think they are much more likely to obtain low-water navigation by the contract method than to trust longer to the government agencies. The lower river country still stands by the commission and its work, as evidenced by the recent action of the Vicksburg convention, since this is their only hope of continuing the allotments for levee building. If the channel can be made navigable by dredging out the bars every year, and if this method should be adopted, they fear a discontinuance of appropriations for other works. This is not simply an assumed motive. They are openly offering this as a sufficient argument against the contract system. The rest of the country, however, do not so regard it.

Finally, the object of supreme importance to the country is an assurance or guarantee that a navigable channel is to be maintained at all stages of the river. Whether improvement under the commission or under a private contract would cost a few thousand dollars more or less, and whether a private company would make or lose money is of no consequence whatever beside the constant assurance in advance that navigation would be possible. Without such assurance capital will not be invested in any line of business which is dependent on such navigation. Without millions of dollars invested in steamboat and barge lines, and without manufacturing interests developed along the river and its tributaries, deep water is of no service. But this capital will never risk itself on uncertainties. Which of these methods, therefore, promises the greatest assurance of continued success? The question almost answers itself. The Eads jetty contract at the mouth of the river answers it. If a private company, under a twenty-year contract, succeeded the second year in keeping the river open, would not this one success, coupled with the tremendous forfeit of say one million dollars for failure, be a sufficient promise and assurance of continued success? I think so. I think capitalists would at once be ready to invest their money in what may be called the river industries. On the other hand, suppose the government claimed for one year to have kept the river open. Would it have any effect? Where is the assurance that it will be done the next year, and the next, and for ten or twenty years continuously? How can future appropriations be relied on? How can it be assumed that a change of officers may not send everything to pot? How, in fact, can it be known with certainty that the channel has been obtained? What third or disinterested party follows up the work to certify to the results? In the case of a private contract it may well be assumed the government officers will not certify to more than has been obtained, especially if they view the work with such jealous eyes as are now cast upon this proposed method. Simply as a business proposition, therefore, I think it by far the better plan to let the work out by contract, to the lowest bidder who can furnish the requisite guarantees, and under a total forfeiture clause, if not entirely successful. One would suppose, also, the commission would be only too glad to so unload the responsibility of successfully carrying out this great work every year with the rigid, cumbrous, military government machinery, which can be so poorly adapted to the unforeseen contingencies and dire emergencies which will constantly arise in the prosecution of this improvement.

St. Louis, Feb. 29, 1896. J. B. Johnson.

United States Geological Survey Monuments.

Sir: I have just read the editorial, in your issue of February 27, on "The Erection of Monuments by the United States Geological Survey." I am pleased with the spirit and tenor of your remarks, and your representations of the facts in the case are, in the main, correct. There are one or two points, however, upon which I might perhaps give you a clearer understanding than you now have.

I have been looking forward to securing the necessary legislation to authorize the erection of monuments in connection with the topographic surveys ever since I took charge of the geological survey, in June, 1894. At the time of the inauguration of the topographic surveys there was no express authority of law for the making of a topographic survey or map of any kind. It was by assuming authority, on the ground that a topographic map was essential as a basis for a proper geologic survey, that the work was undertaken. That the assumption was warranted is proved by the action of Congress in annually appropriating money for the continuance of topographic work. In the appropriations for the survey for the fiscal year 1882-'83 occur the words, "To continue the preparation of a geologic map of the United States," and it was not until the appropriation for 1888-'89 was made that any reference was made to topographic surveys, it being provided in that act "For topographic surveys in various portions of the United States . . . ." This wording has been used by Congress in all subsequent appropriation bills down to the present time.

Last year I undertook a reorganization of the topographic branch of the survey and investigated it thoroughly, with a view to raising the standard of the work. In this connection I asked Mr. Elwood Mead, the State Engineer of Wyoming, to submit his views as to what might best be done to improve and render the topographic maps of greater service to the arid and semi-arid region. Mr. Mead consulted with the State Engineers of Idaho and Colorado, and wrote me at length upon the subject. Under date of January 30, 1896, I submitted to the Hon. the Secretary of the Interior a proposed amendment to the bill carrying the appropriations for the geological survey, providing for the establishment of permanent monuments, etc. The amendment the Secretary of the Interior referred, with favorable endorsement, to the Appropriations Committee of the House of Representatives. Later, the matter was brought by Representative Mondell, of Wyoming, before the Committee on Arid Lands of the House of Representatives, and a resolution was passed—the same that you quote in your editorial. This resolution was in turn referred to the department for report, and a report was made under date of February 10. Mr. Hermann, of Oregon, Chairman of the Committee, then introduced a bill and printed the report upon the original resolution, to accompany it. Copies of this bill and report are herewith inclosed. I suggested a modification of the resolution, and the bill embodies the amended resolution. It provides not only that elevations above sea level, or some fixed point, shall be marked on the ground, by iron or stone posts or bench-marks, in the region west of the 97th meridian, but also that one such mark at least shall be erected in each area equal to a township, six miles square, in the region east of the 97th meridian. If this provision is adopted it will enable the survey to erect monuments not only at the triangulation points, but also to establish monuments and bench-marks wherever they will be of service to the civil engineer, the mining engineer, the geologist, or any one who may desire to ascertain the true position and elevation of points of reference within any particular area.

I do not know that I can state anything further, to make my position clear, beyond what the inclosed report shows. It is my earnest desire that the proposed amendment shall be enacted into law, with a view to raising the topographic surveys to the highest standard of excellence and make them of the greatest usefulness.

Yours, with respect,

Chas. D. Walcott,

Director U. S. Geological Survey.

Washington, D. C., March 2, 1896.

Purification of Water Supply for Railways.

Sir: In view of the article on the supply of pure water for railways in your issue of Feb. 20, I think that the practice of European railways in this matter would be interesting. In Europe the subject has apparently received more attention than it has here, purification tanks being erected at almost all places where the quality of water is such as to require it, this method being used preferably to central stations connected by pipe lines. This is specially the case in France, where every boiler has its purification plant. A case typical of the treatment adopted by European engineers, and interesting from its similarity to that of the Long Island R. R., is that of the Argentine Great Western Ry. Co., illustrating as it does the difference in method and cost of same, for though this railway is in South America it is owned and managed by an English company and has, of course, an English engineer. This railway will form part of the proposed South American trans-continental route (Eng. News, Feb. 13, 1892) and runs from Rosario to Mendoza, 380 miles. The water varies from 37° to 127° of hardness, and is of such a quality that the locomotives required complete overhauling every two weeks, the boiler tubes having constantly to be renewed. All other methods having failed, chemical purification was determined upon. The separate plant system was adopted, and 15 plants were to be erected at various points along the line, a Paris firm undertaking to supply the plant for a sum of $9,000, with a guarantee that the work would be efficiently performed. The contracting firm amply fulfilled its undertaking, and since that time (1889) no trouble has been experienced.

The plants varied in capacity from 1,000 gallons to 2,500 gallons per hour, with a total capacity of 500,000 gallons per 24 hours. The cost per plant was $500 for the smaller and $1,000 for the larger, with a total cost of erection and freight from Havre of $12,000. The cost of chemicals is $200 per annum. In use each plant was erected upon a frame structure at such a height that the purified water flowed from the plant to the supply tank by gravity, the water being pumped up in the first place by mule power W. E. H. Lawrence.

174 West 10th St., New York city, Feb. 22, 1896.

THE STEEL ARCH BRIDGE which is to replace the roadway suspension bridge at Niagara Falls, will have a span of 840 ft. c. to c. of pins, and a rise of 150 ft., the crown of the arch being about 170 ft. above the water. There will be two trusses 26 ft. deep, 68 ft. apart at the skewbacks and 30 ft. apart at the crown. The floor system will be 46 ft. wide, having two electric railway tracks in the middle, two roadways 8 ft. wide, and two sidewalks 3 ft. 9 ins. wide. There will be two shore spans 190 and 210 ft. long. Mr. L. L. Buck, M. Am. Soc. C. E., is the chief engineer, and Mr. R. S. Buck is resident engineer. The foundations were described and illustrated in our issue of Jan. 2, 1896.

THE SIXTH AND EIGHTH AVE. street railways, in New York, says a well-supported rumor, are to be at once equipped as underground electric lines by the owners, the Metropolitan Traction Co. The General Electric Co.'s system, successfully tested on the Lenox Ave. line, will be employed.

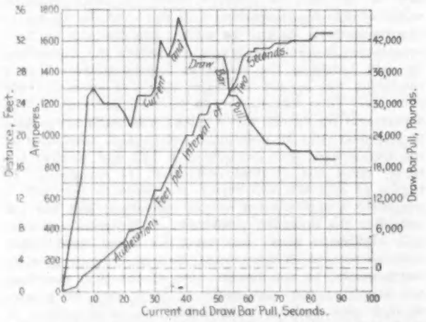


FIG. 1.—DYNAMOMETER DIAGRAMS WITH ELECTRIC LOCOMOTIVE HAULING A TRAIN LOAD OF 910 TONS.

Current and Torque, and Speed Record, of the Start of a Freight Train of 28 Loads and two Dead Engines on a Grade of 0.8 per cent. Weight of train 910 tons.

AN EIGHT-WHEEL PASSENGER LOCOMOTIVE with Wootten firebox has been built by the Cooke Locomotive Works, of Paterson, N. J., to the designs of Mr. G. W. West, Superintendent of Motive Power of the New York, Ontario & Western Ry. The general dimensions of the engine are as follows:

Driving wheels	5 ft. 8 ins.
Truck wheels	2 ft. 9 "
Wheelbase, driving	8 ft. 6 "
Wheelbase, total	23 ft. 1 in.
Weight on driving wheels	76,000 lbs.
Weight of engine	110,000 "
Weight of engine and tender	188,000 "
Cylinders	17 × 24 ins.
Steam ports	1½ × 15½ "
Exhaust ports	3 × 15½ "
Boiler, diameter of barrel	4 ft. 8 "
Boiler pressure	175 lbs.
Firebox	9 ft. × 7 ft.
Tubes, number	197
" diameter	2 ins.
" length	11 ft. 1 in.
Smokestack, diameter	1 ft. 4 ins.
Capacity of tender, water	3,750 gallons.
" " " coal	6 tons.

DYNAMOMETER TESTS OF THE ELECTRIC LOCOMOTIVE ON THE B. & O. R. R.

The first electric locomotive for hauling traffic through the Belt Line tunnel of the Baltimore & Ohio R. R., at Baltimore, Md., was put in service Aug. 4, 1895, and some particulars of its work were given in our issue of Nov. 7, 1895. Dynamometer tests of the power of the engine have been made recently, and we give herewith an abstract of an account of these tests written by Lieut. Lee H. Parker, who has had charge of the installation from the commencement up to the present time. We are indebted to the General Electric Co., of New York, for a copy of this account, and for the diagrams, which latter we have redrawn:

It was shown, from the few trials made with passenger trains, that not only could the guaranteed speed of 30 miles an hour be attained, but that speeds of 35 and 40 miles, with 500-ton trains, were possible. An exhibition of high speed was made with the locomotive running light up the 0.8% grade, and a speed of 61 miles per hour was attained for a short time, without the slightest trouble from trolley or motors. Probably the most striking test was when two trains were coupled together and hauled through the tunnel. This composite train consisted of 44 cars loaded with coal and lumber, two regular steam freight engines and a steam "pusher" engine. The whole weight was approximately 1,900 tons, and was equivalent to about 52 loaded cars. The steam locomotives did no work to assist the electric locomotive. The start was made easily and gradually, but when the train was in the tunnel and entirely on the grade the steady, heavy pull was too severe on a defective coupling near the head of the train, and it parted. After coupling together again, the electric locomotive started the heavy train, with all drawbars stretched—no slack in the train—and accelerated it to a speed of 12 miles an hour, without slipping a wheel. The current recorded on the ammeter was about 2,200 amperes during the acceleration period, and after the train was up to speed it settled down to about 1,800 amperes. The voltage on the line was 625. By reading the amperes we were able to readily compute the drawbar pull, and found it to be about 63,000 lbs. All four motors were in series, and we were, therefore, getting the maximum pull for that current.

It may be of interest to state how we determined the drawbar pull exerted for each ampere of current put into the locomotive. The Pennsylvania R. R. dynamometer car was secured and coupled in between the electric locomotive and a train of known weight. The weight of each car in pounds had been accurately determined beforehand. The regular two-mile haul up grade was then made. When the train was in the tunnel on the grade the pull was uniform, as was shown in the diagrams taken on the dynamometer car.

When no drawbar pull was recorded the pen rested on base line No. 1. The height or ordinate of the irregular curve at any point represented the drawbar pull at that instant. Measuring the same in inches and substracting a constant and then multiplying by 4,000, gave the drawbar pull in pounds, i. e., every inch in height represented 4,000 lbs. The paper traveled under the pen at a rate proportional to that of the train. An irregular line marked No. 2, above the base line, was the planimeter record, from which was determined the mean pull for any time. Having, then, the velocity in feet per minute and the mean pounds pull exerted during any period, we readily obtained the horse power developed.

Another line on the diagram showed the chronograph record, each of the small offsets in the line occurring every five seconds. For every 100 ft. the train moved, the paper moved 1 in. The distance in inches between any two of these offsets gave the velocity of the train. Another line represented the time readings of current and voltage which were taken in the locomotive, a push-button on the locomotive being electrically connected with this recording apparatus. These readings were numbered, so that it was easy to tell the current at any time and location. Still another line showed a record of the different stations in the tunnel. From this we determined the location of the train at any time

The first test showed (1) how the start was made on the down grade leading to the tunnel; (2) how, after the train was fully started, the drawbar pull dropped off, then (3) how it gradually increased as the train came on to the 0.8% grade in the tunnel; and (4) after the train was wholly on the grade, how even the pull was, until near the stop, when the grade increases to 1.2%. Mr. Dunbar, the official of the Pennsylvania R. R., in charge of the car, showed some diagrams of steam locomotive work under similar conditions, and it was seen that their amplitude of vibrations was considerably greater than those of the electric locomotive. This was undoubtedly due to the absence of the angle crank on the electric locomotive, and because its pull is uniform throughout the entire revolution of the armature. Most of the vibrations of the pen shown on these curves were due to vibrations of the dynamometer car, which was mounted on a single truck.

From test No. 1 we obtained the total drawbar pull in pounds, and, knowing the weight of train, we found the drawbar pull to be 22 + lbs. per ton of weight. Subtracting the grade pull, which, in the case of an 0.8% grade, is 16 lbs., we obtained 6 + lbs. per ton as the train resistance. This confirms the usual allowances made for freight train resistance. These observations were taken on a very hot day in September, 1895. During the past winter months the train resistance has increased, due, no doubt, to greater journal friction caused by thickened lubricants, and we find it to be from our records about 20 to 30% greater than in September.

Test No. 2 was made after we had switched off six cars. The run was made under similar conditions and the same character of observations were made. The difference in drawbar pull of the two trains would naturally be the drawbar pull necessary for the six cars switched off. We had their exact weight and were thus again able to find the drawbar pull per ton. It was a check on our first figure, and was very close to it, the slight difference found being due to one brake on the six cars being partially set during the first run unknown to any one.

We had the readings of current during the first run, also during the second. The difference of these should show the current required to haul the six cars switched off. Dividing the difference in the drawbar pulls recorded in the two tests by the difference in current recorded, gives us directly the net drawbar pull in pounds per ampere of current. This was 28.6 lbs.

It will, of course, be noted that by this method we eliminated the current required to drive the locomotive. To determine how much this was, and to check our conclusions, we divided the drawbar pull in pounds recorded in the first test by 28.6 and thus obtained the current that should exert that net drawbar pull. Subtracting this current from the current actually recorded on the locomotive would give the current required to drive the locomotive. We found it took 144 amperes. As a further check we figured similarly for the second test and obtained

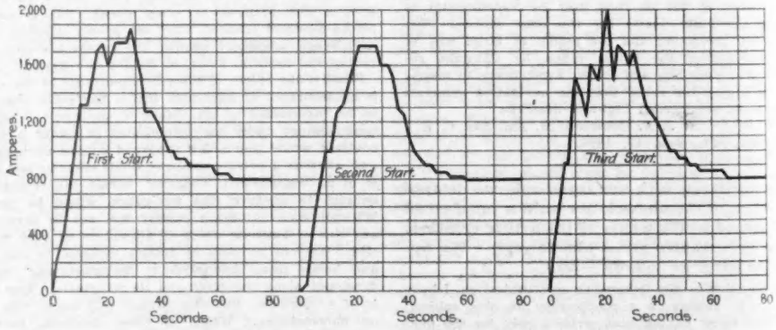


FIG. 2. CURRENT RECORDS OF STARTS WITH A TRAIN LOAD OF 875 TONS ON A GRADE OF 0.8 PER CENT.

precisely the same. So at any time now when hauling a train with the four motors in series, if we take the current indicated on the amperemeter and subtract the 144 amperes needed for the locomotive, and multiply the remainder by 28.6, we have the total net drawbar pull in pounds, and if we divide this by the drawbar pull per ton we get the tons of load we are pulling.

From the results obtained above we were able to show the current and drawbar pull at any moment while accelerating a train. The curves (Figs. 1 and 2) explain themselves very fully.

It may be of general interest to know how the actual operating expenses per engine mile of the electric locomotives, during October, 1895, compare with those of a prominent Eastern railway for the same month.

For the operation of the Baltimore & Ohio tunnel power house for the month of October, 1895, the itemized expenses were as follows:

Labor	$1,345.70
Coal ($1.35 per ton)	400.96
Oil and waste	151.26
Water	50.66
Maintenance	25.42
Total	$1,974.00

The expense on electrical locomotives was:

Motor engineers	$200.00
Oil and waste	12.16
Total	$212.16
Total expense	$2,186.16

There were hauled through the tunnel 353 trains.

Average weight of train	1,095 tons
" time of trip	20 minutes.
" current	986 amperes.
Distance of trip	4 miles.
Total engine travel	1,412 "
" " "idle"	3,756 "
Actual time consumed for above service	118 hours.
Idle time for month	626 "

It is customary to consider an engine with steam up as equivalent to six engine miles for each hour it is idle, so that, for comparison, the actual mileage made by the engines must be increased $6 \times 626 = 3{,}756$ miles.

The large charge of labor at power house will be the same for one, two or three locomotives in service. The items, coal, water and maintenance, and the expense on locomotives, increase with the number of locomotives in service. If we assume this increase to be proportional, the total expense and cost per engine mile are as follows:

	Total cost.	Engine miles.	Cost per engine mile.
For one locomotive	$2,186.16	5,168	$.423
" two locomotives	2,875.36	10,336	.278
" three locomotives	3,564.56	15,504	.23

The steam railway records referred to above are for October, 1895, and may be briefly abstracted as follows:

Steam Locomotive Performance.

	East Div.	West Div.	Cent. Div.	N.&W. Div.	Ent. Line.
No. locomotives in serv..	74	57	33	28	192
Av. eng. mileage in serv..	2,834	2,966	2,293	2,305	2,703
Av. cost per eng. mile.	$	$	$	$	$
Passenger engines	.1926	.1696	.1629	.1552	.1765
Freight "	.2472	.2656	.3428	.2303	.2615
Switching "	.1489	.1659	.1828	.1425	.1577
Work "	.2391	.2258	.2617	.2169	.2354
Total "	.2084	.2193	.2121	.1797	.2095

From the figures given above it is seen that the actual operating expenses of the electric locomotives for that particular month are about the same as for the freight locomotives on the steam railway—23 cts. per engine mile. The service of the electric locomotives at that time was only about one-third that which it is expected they will have to do when the passenger service is taken up and the line extended the full distance.

As originally intended, a method of using to advantage the power of the station while the electric locomotives are idle is soon to be incorporated in the plant, and under the new conditions the cost per engine-mile for the electric locomotives will be far under that of steam.

A comparison of the efficiencies of steam and electric locomotives shows slightly in favor of the electric. Observations made on French railways and on the Pennsylvania R. R. show that only about 45 to 55% of the I. HP. of steam locomotives is applied to hauling trains. The efficiency of the Baltimore & Ohio R. R. plant is in the vicinity of 60 to 65% under normal conditions.

A word may be added as to our experience with the overhead conductor system. The conductor in the tunnel has now been in position for nine months. During all of this time coke-burning locomotives have been used for passenger service, with the consequent presence of a good deal of gas and vapor. For the first six months about half of the conductor was constantly wet from the drip due to leaks in the masonry. This occasioned a muddy, slimy deposit over the insulators and a considerable portion of the conductor. The porcelain insulators are almost entirely obscured in some places by this deposit and that of small particles of carbon given off by the locomotives.

Current was first turned on the line about three months after the tunnel structure was erected. The leak to earth was at first 21 amperes, but, in a day or two, this dropped to about four amperes—the present leakage. The inside of the conductor was coated with a combined deposit of rust and muddy sediment. Heavy currents were taken from it by the contact shoe only with difficulty and the presence of much arcing, heating and showers of sparks. It was found impracticable to run on this surface. By applications of kerosene and frequent scraping with special shoes a direct contact of the trolley shoe with the conductor was made possible. Although a single contact shoe then worked with little or no sparking, two shoes in tandem were adopted. Their operation through the conductor is smoother, and the contact over muddy portions of it is more nearly positive. At intervals of about three weeks the conductor is treated with kerosene, and brushing shoes are run through it, about one or two trips with these brushing shoes being all that is necessary. This serves to prevent the further accumulation of rust and to remove the sediment from the contact surfaces. An inspection shows a smooth surface over which the shoes run. Contact with the metal is seen to be in high spots and thin lines which are slowly increasing in extent. No considerable sparking now occurs, except at the wet places, where it is occasioned by the presence of water and sediment. With the exception of three places, about 200 ft. long each, the conductor is at present dry.

The bolts to the arch of the tunnel are both galvanized and painted, and show no signs of rusting. The painting has, in general, protected the surfaces of the conductor and channels. The sides and top of the inside of the conductor are coated with rust. Most of this is hard and close grained, some of it, however, flaky. In no case is there apparent a reduction of thickness of any of the ironwork due to rusting. Outside the tunnels the conductor is in uniformly good condition. It adapts itself to changes of temperature without trouble. The inside of the conductor is coated with rust, but in no case has there been any trouble from it. The deposit appears to be very light, and there was at no time any sparking between contact shoes and conductor outside of the tunnel.

A LARGE TRUSS IN THE WALDORF HOTEL EXTENSION, NEW YORK CITY.

(With inset.)

The extension of the Waldorf Hotel, on 33d St., New York city, now being built for Mr. Wm. Waldorf Astor, includes an interesting piece of structural work in the shape of a great truss carrying a floor so as to leave a room free from columns underneath. The present part of the extension will be five stories high, but eventually it will be carried up to a height of 16 stories.

The plan, Fig. 1, and general elevation, Fig. 2, show the position and general design of the truss, which is between the second and fourth floors, the first floor (20 ft. above the sidewalk) being suspended from it. The ground floor, 20 ft. below the first floor, is supported by columns carried up from the foundations, and the object of the truss and suspended floor is to secure a large room without columns, to be used as a ballroom until the new hotel now being built for Mr. John Jacob Astor on 34th St. is completed. When this new hotel is completed the ballroom in the Waldorf extension will be changed into a cafe, columns will be put in as shown by the dotted lines in Fig. 2, and the building will be carried up to a height of 16 stories, the present part of the structure only extending up to the level of the sixth floor.

The main problem was to design a truss for temporary service in the partially completed building so arranged that the posts in the truss and the hangers for the first floor would serve afterwards as columns in the completed building. For this purpose it was necessary to so space the posts that their axes would coincide with the axes of the column spacing, while the design had also to be such that the doorways, corridors and other openings would not be interfered with. The details of the construction of the truss, which is 82 ft. 6 ins. long, and 28 ft. 4 ins. deep, c. to c. of pins, are shown in Fig. 3. The specifications require the following quality of steel:

	Medium Steel.	Soft Steel.	Eye Bars.
Ult. strength, max., lbs. per sq. in.	68,000	60,000	66,000
" " min., " " " "	60,000	....	58,000
Elastic limit, min., " " " "	32,000	30,000	29,000
Elongation in 8 ins., min.	22%	26%	...
" 24 ins., nearest fracture	....	....	15%
Reduction of area	....	....	40%

The box girders acting as floor beams, which extend from the wall or abutment columns to the posts of the truss, are supported on the latter by a bearing on the pins, the pin passing through the end plate and bent plate of the girder. The girders are seated between angle iron brackets or shelves, and two 1-in. tie-rods above and below hold the ends of the girders to the columns, to prevent any lateral movement.

The conditions under which the erection was carried on called for the employment of special methods in the erection of the truss, and this work is described below. The top chord of the truss forms a part of the fourth floor while the

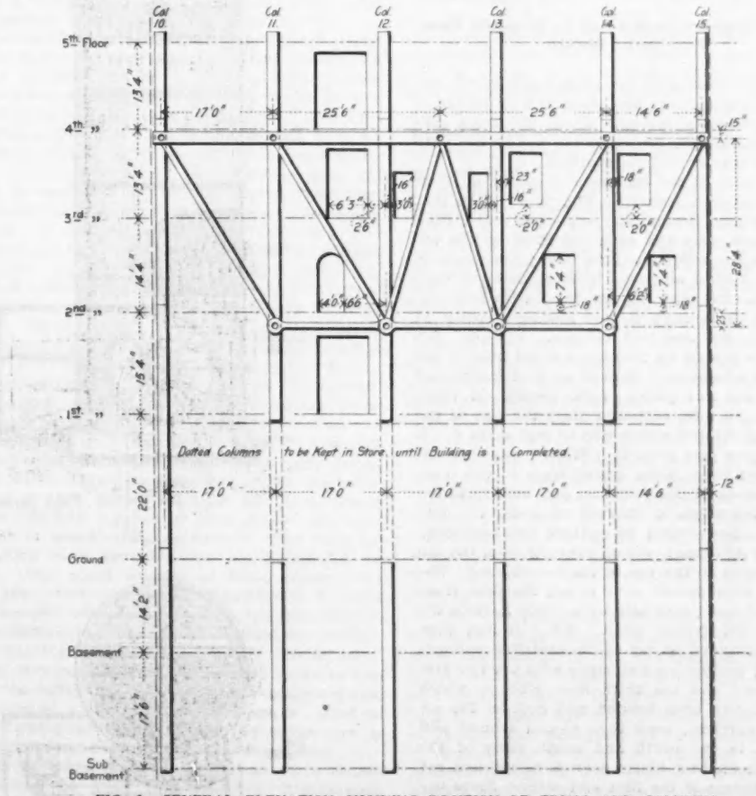


FIG. 2.—GENERAL ELEVATION SHOWING POSITION OF TRUSS AND COLUMNS.

eye bars of the bottom chord are laid in the second floor. The posts of the truss, four in number, are built of channels and plates in the form of box columns, as shown in Fig. 3, and extend from the ceiling of the ground floor to the top of the fourth floor, each post carrying at each floor one end of two floor girders which run at right angles to the length of the truss. A 12-in. I-beam or floor beam also runs from column to column at each floor in each panel. The total length of each post is 47 ft. 0¾ ins., in one piece, the part below the bottom chord acting as a hanger for the support of the first floor girders and beams.

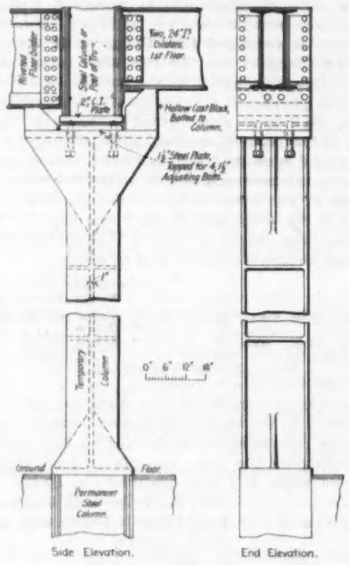


Fig. 3.—Temporary Columns Used for Supporting Truss Posts During Erection.

The girders resting on the truss posts at the second and fourth floors are connected by means of hangers or seats through which the truss pins pass, so that these girders could not be set until the truss was entirely assembled.

The girders of the first floor were set on temporary cast-iron columns, Fig. 5, 12 × 16 ins., with bracketed heads, one being set under each of the truss posts and each one fitted on the top with a screw adjustment for the truss posts to stand on during erection. This adjustment consisted of a steel plate 1½ ins. thick with four 1½-in. tap holes through it, and resting directly on the top of the cast-iron column. A 1½-in. tap screw was passed up through a cored hole in the top of the column and through each of the tapped holes in the nut plate. Laid loosely on these screws was a 2-in. cast-iron plate the size of the foot of the column which was to rest upon it. A 62-ft. Oregon pine pole, 14 × 14 ins., was then set on the first floor, being guyed back to the most distant points of the building, and additional security being given by shoring up under the derrick. Erection began by setting the east supporting or abutment column running from the top of the second to the top of the fourth floor. The pole was then moved west to set the first truss post, which had previously been rolled in from the street on the ground floor. When it had been raised and landed on top of the cast-iron column, temporary connection was made with the two first floor girders and the third floor girders, which had previously been hoisted and held in the air on house derricks, were then swung around and connected to the north and south sides of the post, while another house derrick raised and set the floor beams of the first and second floors between the supporting column of the truss and the first post, thus effectually connecting the post to the rest of the building.

This operation was then repeated with each of the posts in turn and the third floor completed. The top chord was then set with house derricks standing on the third floor, and the eye bars for the diagonals and bottom chord were lowered into place from the third floor, on which they had been hoisted from the street by a boom derrick standing on the same floor. The second floor girders and beams were then set by means of tackles hung from the third floor, at the same time the house derricks were setting the fourth floor, all the material for the second and third floors having been hoisted to the first floor before the setting of the truss began. The truss posts weighed from 9 to 15 tons and the pins were 8 and 10 ins. diameter, some weighing 1,500 lbs.

After completing the truss the adjusting screws under the posts were slacked off and the cast columns removed, leaving the truss carrying the upper floors and leaving the ball room clear of all columns.

One of the difficult points of the problem was to provide for putting in the columns which are omitted in the original construction, and the method for doing this is one of the most interesting features of the building. Upon each column foundation is an iron base casting carrying the steel base of the column, a set of filler plates ⅛, ¼ and ½-in. thick being interposed between them, as shown in Fig. 4, the total thickness of these plates being about 2½ ins. When the new columns are to be inserted, a hydraulic jack will be placed in the opening provided in each base casting, and the columns raised to allow of the filler plates being removed, then the columns will be lowered, the additional columns shown by dotted lines on Fig. 2 put in and brought to a bearing, filler plates put in as required to take up the altered distance between the base casting and column base, the jacks removed, and the openings permanently filled with concrete. The principle of this plan is similar to that employed by the same engineers in the foundations of the Marquette Building, Chicago, to provide for any possible unevenness of settlement (Eng. News, Oct. 17, 1895).

The architect for the Waldorf extension is Mr. H. J. Hardenbergh, of New York, and the consulting engineers for the building and the new hotel on 34th St. are Messrs. Purdy & Henderson, of New York and Chicago, by whom all the structural work (including the truss and the adjustable column foundations) was designed. The truss was built by the Edge Moor Iron Works, of Wilmington, Del., but all the rest of the ironwork was furnished by, and all the erection done by, J. B. & J. M. Cornell, of New York city, the details of the method of erection being personally designed by Mr. J. M. Cornell. Mr. F. S. Harrison, who had charge of the erection of the ironwork of the American Tract Society Building (Eng. News, Dec. 27, 1894), is engineer in charge of erection for Messrs. Cornell. We are indebted to Messrs. Purdy & Henderson for the drawings from which our illustrations are prepared.

A NEW SELF-COOLING CONDENSER.

The difficulty of obtaining condensing water is the chief obstacle to the use of condensing engines in locations which are not immediately adjacent to a running stream or other free and abundant water supply. To overcome this difficulty numerous schemes have been tried, such as the construction of large ponds for cooling the water, so that it may be used over and over, of air surface-condensers, in which air instead of water is used as the cooling medium, and of evaporative surface condensers, in which water trickles over the condenser tubes, cooling them by its evaporation. Besides these methods another is to have the hot water discharged from the condenser cooled by passing down through a tall vertical wooden structure, being intercepted in its fall by numerous shelves or shallow tanks, a fan at the bottom supplying an air blast for cooling by evaporation. All of these methods are objectionable on account of the great bulk of the apparatus and its consequent great first cost. A patented self-cooling condenser, recently introduced by Henry R. Worthington, Brooklyn, N. Y., which we illustrate herewith, seems to have all the advantages in saving of condensing water and in efficiency of action offered by any of the air-cooling methods, with the additional advantage of durability, saving of space and of cost.

In this apparatus the warm water discharged from the condenser is carried to the top of a tall cylindrical stack which is open at the top, and is

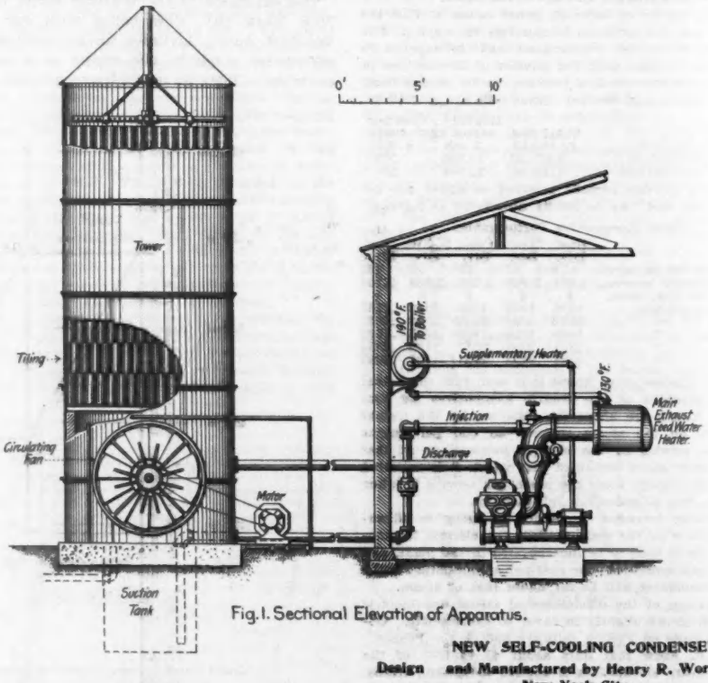


Fig. 1. Sectional Elevation of Apparatus.

NEW SELF-COOLING CONDENSER.
Design and Manufactured by Henry R. Worthington. New York City.

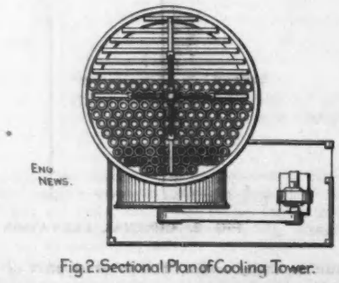


Fig. 2. Sectional Plan of Cooling Tower.

filled with a cellular structure made of 6-in. terra cotta pipes about 2 ft. long. The pipes are stood on end, packed close together, so that each "breaks joint" with those beneath and above it. The water is discharged over the whole cross section of the stack by four distributing pipes which are caused to rotate about the central water pipe by the reaction of the jets escaping from one side of each. The central pipe is left open at the top, so that in case of any clogging of the jets of the distributing pipes the water may flow out of the top of the central pipe. The water thus distributed trickles down both the outside and inside of the terra cotta pipes, and falls into the suction tank at the bottom. A disk fan driven by a small motor or engine, or by a belt, as may be most convenient, furnishes a blast of air at low pressure, which cools the water during its fall. The cooling of the water is accomplished in three ways, first and least by external radiation from the stack, next by contact with the cool air, and last by evaporation. In winter the contact of the air is the chief cause of the cooling, and in summer evaporation is the chief cause. The relative proportions of the work done by contact and by evaporation depends upon the humidity of the atmosphere as well as upon its temperature.

The efficiency of the apparatus will depend, of course, both upon the temperature of the air supply and upon the size of the condenser or the amount of cooling surface provided. For condensing the steam of an engine of 1,000 HP., using 20 lbs. of steam per HP. per hour, we are informed that a stack 32 ft. high by 17 ft. diameter is ample, the condenser pump circulating 1,500 gallons per minute. The fan is 9 ft. in diameter and requires 2% of the total power of the engine to drive it. No water needs to be supplied to the system other than that fed to the boiler, the boiler feed making up entirely for the loss by evaporation in summer time, and in winter a small surplus escapes from the overflow from the suction tank. The suction tank, holding 3,000 gallons, is filled on starting the plant and never requires refilling. The vacuum varies from 26 ins. in winter to 22 ins. in the hottest summer weather. With a temperature of the external air of 95° the discharge water entering the tank at 140° would be cooled to 105°. With an air temperature of 70° the water would be cooled to 80°, the discharge being 110°.

In the illustration the condenser shown is the ordinary Worthington independent condenser, with a duplex pump capable of elevating the water to the top of the cooling tower. With the ordinary form of air pump which simply discharges the water at atmospheric pressure, an additional pump would be required to elevate the water. The amount of steam used by the pump may be made very small by the arrangement for utilizing the exhaust steam from the pump which is shown in the cut. Before the exhaust from the engine reaches the condenser it passes through an exhaust feed water heater, which heats the boiler feed to about 130°, which water is then carried to a supplementary heater which utilizes the exhaust from the pump and heats the water to about 190°. Instead of using the first exhaust heater for the preliminary heating of the feed water it may be taken directly from the discharge pipe, the amount of water thus taken from the system being replaced by an equal quantity of cold water, fed into the injection pipe.

This self-cooling condenser has already been tried at a sufficient number of plants to prove its effectiveness. One of 200 HP. has been in constant service since June, 1894, maintaining during the hottest weather a vacuum of 22 ins., and in cooler weather often as high as 26 ins. Others are in operation ranging from 400 to 1,000 HP., and orders for three installations of, respectively, 1,200, 2,500 and 5,000 HP. are under construction.

An important advantage this condenser has over the air-cooled and evaporative surface condensers is that no vacuum needs to be maintained in the tower which is entirely open to the air. In surface condensers the whole structure, including the piping, requires to be absolutely air-tight. In the Worthington system only the piping conveying the exhaust steam to the condenser needs to have the vacuum maintained in it. An important saving is thus made in construction and in maintenance.

NOTES OF EXCURSIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS AT THE PITTSBURG MEETING.

(Editorial Correspondence.)

The report of the Pittsburg meeting of the American Institute of Mining Engineers, which we printed last week, was confined to an account of the sessions for the reading and discussions of papers. The excursions, however, are usually the most important features of a mining engineers' meeting, and the following are notes of the principal features of interest seen by our representative:

Jones & Laughlins, Limited.—This is one of the most extensive iron and steel works in Pittsburg. According to the 1894 "Directory of Iron and Steel Works," it contains 92 puddling furnaces, but only the week before our arrival the last of these furnaces had been abandoned. The works now contain two 9-gross ton Bessemer converters, built in 1886, and two 20-ton open-hearth furnaces, which have just been put in operation. A specialty for which the firm has long been famous is cold-rolled shafting. It was formerly made of iron, but is now made of steel. The cold rolling shops look about the same as they did 15 years ago. The shafts after being rolled hot approximately to size are, after cooling, re-rolled slowly and carefully in very heavy rolls, which decrease their diameter a trifle at each pass, and make them perfectly round and smooth and considerably increase their strength. After rolling, the shafts are tested all over for straightness, and carefully straightened by power presses. In addition to cold-rolled shafting, this department makes cold-rolled flat bars, angles and other shapes for agricultural machinery and other purposes. Connected with the shafting department is a large foundry and machine shop for the manufacture of flywheels, pulleys, hangers, couplings, etc., in which a very large business is done. The rolling mills are of great extent, and have a combined capacity of about 500,000 tons per annum. One of the older mills has been remarkable for many years for all of its roll trains being driven by belts from overhead shafting, a quite unusual method of driving roll trains. Among recent improvements in the works are two continuous roll trains for rolling bars. The continuous mill appears to be the coming mill for a great variety of work, but it is remarkable how slow has been its introduction. One has been in operation in the mill of the Washburn & Moen Mfg. Co., in Worcester, Mass., for many years, for the manufacture of wire rods, and another has been used for about 15 years for making pipe skelp by the National Tube Works Co., at McKeesport, Pa., but until recently other manufacturers have apparently been afraid to adopt them. Of the two at Jones & Laughlins', one is used as a finishing mill, receiving blooms rolled to about 6×4 ins. directly from a reversing blooming mill, which rolls these blooms from large ingots, and rolls them without reheating down to various sizes of flat bars. The other is an independent mill which takes 4 × 4-in. reheated steel billets and rolls them in nine continuous trains down to a rod about 1½ ins. diameter, which is then passed by hand into an ordinary guide mill and finished in three passes to a 1-in. round, or smaller size, as desired. The rods are delivered to a straightening bed about 125 ft. long. The small amount of labor required by this process of continuous rolling should, it would be thought, eventually lead to the adoption of the continuous mill for all ordinary bar rolling. The heating furnace used for this mill is something of a novelty. Its bed is built on an incline and the billets are charged by a machine at one end, one at a time, and as each one is placed in the furnace at the cool end, the whole row is pushed forward 4 ins. towards the hot end.

The Fort Pitt Foundry.—The next place visited was the old Fort Pitt Foundry. Machintosh, Hemphill & Co., proprietors, which was made famous during the war of the Rebellion by its casting of heavy guns. It has recently been modernised, and provided with an equipment of electric cranes. It is equipped with the heaviest kind of machine tools, and its capacity for heavy castings is limited only by the ability of the railways to transport them. Some of the castings now being machined weigh 65 tons each, and have to be shipped on special cars with two four-wheel trucks under each end, or 16 wheels in all. Among the jobs now in progress are a reversing blooming mill, direct connected, engine, for Jones & Laughlin, with two cylinders, each 50 × 72 ins., with piston valves and hydraulic reversing gear; another blooming mill engine for the Troy Steel Co., with two cylinders, each 42×60ins., geared 5 to 7; a 32-in. universal slabbing mill for the Bethlehem Iron Co., with reversing engines, 46×60 ins., for driving the horizontal rolls, and 28×60 ins., for the vertical rolls, two cylinders for each engine, all with piston valves; and a hydraulic shear to go with the slabbing mill, for cutting the slabs.

The Star Tin Plate Co.—This is a new establishment built adjoining Mackintosh, Hemphill & Co.'s, which has only recently commenced operations. When complete it will have a capacity of 1,200 boxes of tin plate per day. It is a large finely-constructed and well-lighted mill, and is said to be equipped with all the latest improvements. The manufacture of tin plate appears to be a very simple operation. The steel which forms the principal part of the tin plate is received at the mill in the shape of flat bars, 6, 7 or 8 ins. wide, by from ¼ in. to ¾ in. thick, and 30 ft. long. These are sheared to length according to the size and weight of sheets to be made, and rolled in ordinary two-high mills down to sheet. During the rolling the pieces are doubled—that is, two are rolled together, until finally eight thicknesses are rolled at one time. The sheets thus rolled are pulled apart, as they have a tendency to stick together, and are pickled to remove scale, cold rolled, annealed in cast-iron boxes, which are closed so as to prevent oxidation of the sheets, thoroughly cleaned in acid, dipped in oil, then dipped into the pots of melted tin, passed through rollers which remove the surplus tin, and brushed free from grease by sawdust, the brushing being done by machinery. The plates are then carefully inspected and packed for shipment. The machinery is all of the very latest type, and of recent American invention, so it is claimed, but it seems remarkable that the most laborious operation of all, the rolling of the bar into sheet, is practiced just as it was 50 or 100 years ago. The continuous mill would appear to be the next improvement needed in the tin plate mills, and I am told that Mr. Julian Kennedy is now designing one for the tin plate works at Apollo, Pa.

The Shoenberger Steel Co.—This is one of the oldest concerns in Pittsburg, having been founded in 1826 by Peter Shoenberger. It was once famous for the old "Juniata" iron boiler plate, now no longer made, but the reputation of the old concern is equalled by that of the present owners for fine open-hearth steel boiler plate. The works is a quaint mixture of the old and the new. It occupies four blocks of ground in a thickly-settled district, and within this limited area are crowded two blast furnaces with their stock yard, a Bessemer plant with two converters, two open-hearth furnaces, a blooming mill, a plate mill, a sheet mill, a puddle mill with its squeezers, muck bar and finishing trains, a horseshoe factory and a nail factory. Although many of the buildings are ancient the equipment is largely modern, and the steel works are gradually encroaching upon the puddle mill. A new continuous mill has lately been put in to roll flat bars, and experiments are now being made in rolling various shapes with it.

The Excursions on Wednesday.—The whole of Wednesday was devoted to an excursion by rail to three establishments—viz., the Homestead and the Edgar Thomson Works of the Carnegie Steel Co. and the new plant of the Westinghouse Electric & Mfg. Co. at East Pittsburg. A brief account of each of these works was given by your correspondent in Engineering News of Oct. 10, 1895. The most notable feature of the visit to the Homestead Steel Works was an exhibition of the forging of a 50-ton armor-plate under the great 10,000-ton hydraulic forging press. The plate, which had previously been partly forged, and was in the reheating furnace when the party arrived, was withdrawn from the furnace, the whole furnace bottom moving out on wheels, and transported by an electric traveling crane to the press. It was turned over by means of an endless chain operated from the crane, and, beginning at one end, it

was quickly compressed 2 ins. in thickness at each stroke of the press, being pushed along over the anvil about 6 ins. after each stroke. The ease with which the whole operation was conducted was remarkable.

One of the numerous instances of the control of mind over matter which was seen at every point in this vast works was an electric trolley car, which conveyed steel blooms from a roller-conveying table in front of a train of rolls to an electric charging machine in front of a reheating furnace. The trolley car was provided with a motor and controller, as usual, but it had neither motorman nor conductor (except a wire conductor). A man operated the charging machine while riding upon it by moving electric switches, and the same man telegraphed to the trolley car all the necessary motions for it to perform, which were accomplished, apparently, without human agency. The large party walked about the works for over two hours, but your correspondent, with a few others, was invited to a department which the main party missed. It was:

The Department of Micro-Metallography.—Not satisfied with laboratories for physical and chemical investigation of the many mysteries of steel, the company has fitted up a special laboratory for the purpose of microscopical investigations. It contains a magic lantern provided with an arc electric light and numerous lenses for magnifying and throwing upon a screen, when the room is darkened, enlarged images of the microscopic structure of steel, and an apparatus for making and enlarging micro-photographs. When a piece of steel is to be examined microscopically, a surface is polished perfectly, etched in very dilute acid until its structure is visible under the microscope, then it is placed in the lantern and the magnified image of a minute portion of the surface is thrown upon a white paper screen, where its topography, so to speak, may be studied and permanently recorded by drawing its outlines with a pencil. For more complete diagnosis the microscopic structure is directly photographed. Not only does every different kind of steel have its own peculiar structure, which may be recognized by the "metallographer," but each piece of steel may have its microscopic structure changed by heat treatment. The micro-photograph may thus be used to show changes in structure due to different finishing temperatures used in rolling. Two pieces of the same steel, one finished at a temperature of 150° F. higher than the other, exhibited a difference of structure so great that the grains of the one finished at the higher temperature appeared to be 50% larger than those of the other.

The microscopic study of steel is still in its experimental stage. Its practical value has not yet been fully determined. A similar study is being carried on at the works of the Illinois Steel Co. in Chicago. Those further interested should consult the paper on "Microscopic Metallography" by F. Osmond, of Paris, in the transactions of the American Institute of Mining Engineers for 1893. The most recent publication on the subject is a bulletin of the Societe d'Encouragement pour l'Industrie Nationale, of Paris, in 1895, entitled "L'Analyse Micrographique des Aciers au Carbone," par F. Osmond.

The Westinghouse Electric and Manufacturing Co.—The immense new plant of this company at East Pittsburg was next visited. The plant consists of a main building 754 ft. long by 231 ft. wide, one story, 67 ft. high to the ridge of the roof truss in the center, with galleries 80 ft. wide on each side, 25 ft. above the floor; a warehouse and office building, 574 × 76 ft., two stories high; a power house, 206 × 76 ft., containing boilers engines and electric generators which supply current to the main building for driving machinery, for lighting, and for experimental purposes; a storing, punching and annealing house, 258 × 76 ft., two stories high; a blacksmith shop, 241 × 80 ft; a brass foundry, 241 × 40 ft.; and a paint shop, drying room and oil house, 187 × 25 ft. Besides these there are carpenter and box shops, and a pattern storage building. An extensive iron foundry is projected.

As but little over an hour was allowed for visiting the works, after luncheon provided by the company at the commodious waiting room of the railway station, only a general impression of the vastness of the establishment and of the perfection of its equipment could be obtained. The product of the works is electric generators, motors, switches, transformers, controllers, measuring apparatus, etc., in immense variety; and in addition to actual manufacturing a large force is constantly employed in designing, drafting, testing and experimenting. Among the novelties seen were the new Baldwin-Westinghouse electric locomotive, the first one that has been completed. It looks like a rather clumsy electric street railway car, provided with a pilot at each end, and mounted on two four-wheel trucks, the wheels being 42 ins. diameter. Each of the four axles is driven by a 200-HP. single-geared motor carried under the car. The locomotive when completely equipped weighs 160,000 lbs., all of which rests on the eight driving wheels.

The experimental track of the Westinghouse electric railway system, in which the wires are under ground, which was briefly described in our issue of Oct. 10, 1895, was shown to the visitors, and its method of working explained. The new electric locomotive is soon to be tested on this track. Another novelty seen in operation was the new gas engine by which Mr. Westinghouse says he expects to utilize 50% of the heat energy of coal. It is a three-cylinder engine, working on the Otto cycle, compounded, with one high-pressure and two low-pressure cylinders. The initial compression is as high as 375 lbs. per sq. in., and the compounding gives a high rate of expansion.

The Edgar Thomson Steel Works.—No very important changes have been made in these works in the past five years. The finishing shop of the rail mill has been lengthened 300 ft., making it now nearly 1,200 ft. long, in order to handle more easily the 60-ft. rails which are now being called for by some railways. The large blast furnaces are now making regularly over 400 tons of iron per day each, and one of them, furnace I, has beaten the world's record for endurance, having produced 600,000 tons of iron without relining.

The Glass Works at Jeannette.—On Friday's excursion the first place visited was the window glass works of McKee Bros., at the new town of Jeannette, 27 miles east of Pittsburg. The principal feature of interest here was the immense continuous glass melting tank, 125 ft. long, and 25 ft. wide, holding 750 tons of molten glass. It is built on the Siemens regenerative principle, a series of regenerators, with the flues, valves, etc., being built along the sides. The sand, soda, and other glass melting material, which are thoroughly mixed in an adjoining building, are charged into one end of the furnace by means of a "peel" or shovel, the long iron handle of which runs on rollers, and which is easily pushed in by hand and turned upside down so as to dump the charge well inside of the wall. The charge as it melts travels very slowly towards the other end of the furnace, freeing itself from air and impurities as it goes, and is drawn by the glass blowers and blown into tall cylinders, which are afterwards cut and opened out into a flat sheet, in the manner that has been practiced for centuries.

A factory for the production of pressed and blown glass for lamp chimneys, table ware, etc., immediately adjoining the window glass factory, was also visited. In this factory the old-fashioned melting pot furnaces are used. This is one of the largest factories of its kind in the country, and the great variety of operations required in the production of hundreds of different shapes, the number of furnaces, annealing ovens, pressing machines, patterns, etc., and the immense stock of goods on hand, were all very impressive.

The Latrobe Steel Works.—Of all the works visited by the excursionists the Latrobe Steel Works was probably the most novel, and in some respects the most satisfactory. It is not so large nor so varied in its products as the others, and consequently it was possible to inspect it thoroughly and watch every operation. Its product is almost exclusively rolled steel tires for car and locomotive wheels. The steel is made in two 20-ton open-hearth furnaces. It is cast by the method of bottom pouring, through a central gate and horizontal channels, in the shape of short cylindrical ingots with hemispherical tops, which are technically known as "cheeses," each cheese being made of a weight just sufficient for one tire. The ingots are heated by natural gas in a long furnace whose bottom is an inclined plane. They are charged at the upper or cool end, and are gradually rolled down to the hot end. In making a tire the cheese is taken from the furnace by a manipulating device, which clasps the cylinder just as a man might clasp an apple between his thumb and fingers; it is carried to a 20-ton hammer, which with a few heavy blows flattens the cheese into a cake 5 or 6 ins. thick. A revolving table fixed near the anvil then moves onto the anvil block, bringing into a central position on the block a sort of flat punch with curved sides; the cake is laid on the punch, and a few blows of the hammer drive the punch into the cake, making a hole. Enlarging punches or drifts are then in succession placed in position on the anvil by the revolving table, and by more hammer blows the hole is enlarged till it is a foot or more in diameter. The manipulator then takes the cheese to a 7-ton hammer, hangs it by the hole upon a stubby horn on one side of the anvil, and by revolving it around the horn, and continual hammering, the hole is still further enlarged. The half-formed tire thus made is then put in a reheating furnace. After being heated to a scaling heat it is then taken to the tire rolling machine, a complicated structure containing a central vertical roll and four idler rolls surrounding it which are movable radially to and from the central roll by hydraulic plungers and connecting links, also one driven forming roll, which is operated through a bevel gear by a powerful engine. By the pressure of this forming roll against the central roll and the rapid driving of the former the tire is gradually expanded to the diameter required, a stream of water being thrown upon it constantly during the process. At the same time the tire is brought to the proper thickness between its flat sides by means of two horizontal rolls, one driven by the engine, and one by friction of the tire itself, the upper one being forced downwards by hydraulic pressure. When the tire has been rolled nearly to size the machine is stopped and the tire is carefully gaged; a few additional turns of the rolls are given after each gaging, until the desired diameter has been reached. There are two tire-rolling machines like the one described, and their combined capacity is over 20 tires per hour. By changing the rolls different sections of tire may be made, and besides tires flat rings for heavy pipe couplings and heavy pipe flanges have also been made. The whole operation of making the tires is a triumph of mechanical engineering. After the ingots are cast practically the only manual labor required is that required to move the controlling levers of the several machines which do the work.

The Pennsylvania Salt Co., Natrona, Pa.—After leaving Latrobe the party was taken via. the West Pennsylvania Branch of the Pennsylvania R.R. to Natrona, on the banks of the Allegheny River, 23 miles above Pittsburg, and an hour was spent in the chemical works of the Pennsylvania Salt Co. This is an immense establisament, famed as the only concern which uses the mineral cryolite, imported from Greenland, a fluoride of sodium and aluminum, containing other chemical substances, in the manufacture of soda, hydrofluoric acid, etc. It also makes acids of all kinds, concentrated lye, etc., and from imported Spanish copper pyrites makes sulphuric acid, copper by combined chemical and electrolytic process, and the residue "blue billy" which is sold for use as an iron ore. The works consist of furnaces, vats, tanks and machinery in great variety, and of various degrees of antiquity and apparent dilapidation. By some oversight the excursion committee had not secured a force of guides to take the party through the works, and the party wandered about at will, breathing acid fumes and inhaling the dust of potash, most of them, the chemical engineers possibly excepted, gaining no information which would enable them to understand any of the various processes. Later in the afternoon the party returned to Pittsburg, thus closing one of the most interesting and successful excursions which the Mining Engineers have ever enjoyed.